CAPTURING AND MAINTAINING THE CLIENT'S REQUIREMENTS

Full Paper

NECESSARY SKILLS AND PRACTICES REQUIRED FOR EFFECTIVE PARTICIPATION IN HIGH BANDWIDTH DESIGN TEAM ACTIVITIES

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ABSTRACT

Technology is continually changing, and evolving, throughout the entire construction industry; and particularly in the design process. One of the principal manifestations of this is a move away from team working in a shared work space to team working in a virtual space, using increasingly sophisticated electronic media. Due to the significant operating differences when working in shared and virtual spaces adjustments to generic skills utilised by members is a necessity when moving between the two conditions. This paper reports an aspect of a CRC-CI research project based on research of 'generic skills' used by individuals and teams when engaging with high bandwidth information and communication technologies (ICT). It aligns with the project's other two aspects of collaboration in virtual environments: 'processes' and 'models'. The entire project focuses on the early stages of a project (i.e. design) in which models for the project are being developed and revised. The paper summarises the first stage of the research project which reviews literature to identify factors of virtual teaming which may affect team member skills. It concludes that design team participants require 'appropriate skills' to function efficiently and effectively, and that the introduction of high band-width technologies reinforces the need for skills mapping and measurement.

Keywords: virtual teams, generic skills, design teams.

INTRODUCTION

Environmental and technological changes have impacted on the way in which construction teams function. An historical trend in the construction industry has been that each time a project team is formed the make up of it's members (both at an individual and organizational level) changes, ensuring that there is little or no consistency in membership (Emmitt and Gorse, 2003). A major driver of environmental change has been a move towards more collaborative contractual arrangements, such as alliancing and partnering (Love et al., 2002), which, in turn, promotes technological change. Longer term relationships between project team participants act as drivers for the uptake of new technologies. Investing time and money in new computer hardware and software is more attractive if such technologies can be used on many projects, with the same people.

With regard to the nature of teams, technology (i.e. cost of technology, speed of information transfer and the associated costs) promotes moves from co-located to more virtual team activities. However, the challenge of such a move is to incorporate aspects of co-location, for example, seeing people whilst interacting with them, and the ability to collaborate on issues such as developing an aspect of a design, within a virtual environment. This paper reviews literature on the issues of teamwork, virtual teaming, generic skills involved with teamwork and virtual teams. These issues are examined in the environment of early design from a broad range of industries, and conclusions to date are presented.

COMPOSITION AND NATURE OF TEAMS

As time and technology move forward, and design projects become more complex, relationships, roles, and responsibilities have become more varied. It is through the sharing of ideas that superior products are created and delays and miscommunication are avoided (Maher et al., 2000). Teams are a cluster of two or more people usually of differing roles and skill levels who interact '*…adaptively, interdependently, and dynamically towards a common and valued goal.*' (Salas et al., 2000). They are the vehicle for the process of collaboration (Beyerlein et al., 2003). In a majority of organisations there exists a wide variety of challenges and issues.

Collaboration or partnering may be achieved through many forms of interaction. A succinct summary is provided by McDonough III et al (2001) who distinguish between various teams:

- **Co-located -** comprised of individuals who work together in the same physical location and are culturally similar.
- **Virtual -** comprised of individuals who have a moderate level of physical proximity and are culturally similar. One example of virtual team is when team members are in the same building but on different floors.
- **Global -** comprised of individuals who work and live in different countries and are culturally diverse.

Co-location is the principle way that teams operated before technology gave team members an ability to communicate with others in different physical locations. Co-located teams, are those whose members operate in the same physical and cultural space (McDonough III et al., 2001). Collocated teams interactions are synchronous, occur in a similar place, and their members may be culturally different in terms of

different organisations. However, with increasing globalisation of projects it is becoming harder to collocate these national and global team members (McDonough III et al., 2001).

Virtual teams exist when the members of a team are culturally similar but operate, for the majority, in different physical spaces such as different cities within the same country (Lurey and Raisinghani, 2001; McDonough III et al., 2001). As clients of construction and design companies demand more efficient and higher quality services, use of diversely located team members on the one project may increase (Kimble et al., 2000). This need for efficiency (Kayworth and Leidner, 2000) and group interaction has lead to increased partnering between companies of differing fields (Love et al., 2002). Due to difference in location, team members now increasingly use electronic media to communicate ideas and designs (Jaafari and Tooher, 2002).

A global virtual team exists when virtual team members are also culturally displaced, such as in international collaboration (Kayworth and Leidner, 2000). A majority of definitions of global virtual teams suggest that they are temporary in nature with a lifespan related to a specific project (Jarvenpaa and Liedner, 1998).

ISSUES OF GENERIC SKILLS ARISING IN A VIRTUAL CONTEXT

When attempting to change the context of a team from co-located to virtual it is important to factor in skills possessed by team members and how these may be affected. Generic skills are defined by Salas et al (2000) as, *"…the knowledge, skills and attitudes that a team member possesses when completing a task or communicating with fellow members, whether in a co-located or virtual environment"*. Generic skills influence both individuals and teams; they are skills which are *"…transportable and applicable across teams."* (Salas et al., 2000).

CORE GENERIC SKILLS IN A VIRTUAL CONTEXT

Problems exist in the transfer of information, and the ability to utilise these skills, in a virtual team context, and are generally centred on team members' abilities to communicate using these skills. For example, when someone attempts to give feedback in a virtual team they can be limited by the level of communication dictated by the virtual technologies available to them. The main area for concern for virtual teams is the ability to communicate, especially non-verbal communication which is more difficult in the majority of virtual communication. The impact of this limitation of skills is most prevalent in relation to team management, feedback and trust. Relevant skills, derived from the literature, are shown in Table 1.

Literature has illustrated that attempts to transfer the skills outlined in Table ,1 from a co-located environment to a virtual one, have met substantial resistance. It becomes clear that need or use of these skills would differ between co-located and virtual teams.

Table 1. Integrated skills (as adapted from Cannon-Bowers et al 1995 [Salas et al., 2000]).

Core Generic Skills	Definition	Sub skills
Adaptability	The use of compensatory behaviour and reallocation of resources to adjust strategies based on feedback	• Flexibility • Compensatory behaviour • Dynamic reallocation of functions
Shared situational awareness	When team members have compatible mental models of the environment within and outside of the team.	• Orientation • Team awareness • System awareness
Performance monitoring and feedback	Ability of team members to give, seek, and receive task clarifying feedback.	• Performance feedback • Acceptance • Mutual performance monitoring • Procedure maintenance
Team management: Project management/leadership	Ability to direct and co-ordinate the activities of other team members particularly pertaining to performance, tasks, motivation, and creation of a positive environment.	• Task structuring • Motivation of others • Goal setting • Goal orientation
Interpersonal relations	Ability to optimise the quality of team members' interactions.	• Conflict resolution • Assertiveness • Moral building
Co-ordination	Process, by which team resources, activities and responses are organized to ensure that tasks are integrated, synchronized and completed within established temporal constraints.	• Task organisation • Task interaction • Timing
Communication	Information exchange between members using the prescribed manner and terminology.	• Information exchange • Consulting with others
Decision making	Ability to gather and integrate information, use sound judgment, identify alternatives, select the best solution, and evaluate the consequences.	• Problem assessment • Problem solving • Planning • Implementation

Below are descriptions of these generic skills, and major issues relating to them.

- **Adaptability** – increase in use as team members need to adopt changes associated with the virtual environment i.e. communication methods, such as electronic whiteboards, as opposed to face-to-face (Baldwin, 2004).

- **Shared Situational Awareness** – increase in the need for skills in creating a 'shared situational awareness', due to distance and the sometimes fragmented communication channels between team members. An increase in these skills can be seen in creation of a shared (i.e. the web) bulletin board which assists in uniting team member's cognitions (Lipnack and Stamps, 2000).

- **Performance Monitoring and Feedback** – skills in delivering feedback may be impeded in a virtual team due, again, to the restrictive nature of communication (most significantly non-verbal communication). These limitations may be combated by increasing the number of communication channels used. While not allowing tactile communication it will enhance the experience for receivers (Emmitt and Gorse, 2003).

- **Team Management** – skills in team management including project management and leadership are again disabled because of difficulties in establishing free and clear communication (i.e. like face-to-face conversation); for example to control conflict using only email, between two team members. However, operating in a virtual team allows for management to be based on up-to-date information and instant data transfer, in this respect creating an ability to use management skills efficiently.

- **Interpersonal Relations** – sub-skills of this skill such as assertiveness (Alonzo and Aiken, 2004) and conflict resolution (Furst et al., 1999) may be difficult to use in a virtual environment. The virtual environment creates an atmosphere of 'ambiguous' communication, where it may be difficult to interpret whether a person's communication, is promoting unhealthy conflict, or simply assertive (Furst et al., 1999).

- **Co-ordination** – Co-ordination for the construction industry refers to the ability to deliver 'accurate and timely information (Emmitt and Gorse, 2003) for decision making and problem solving'. Virtual technologies could aid co-ordination significantly. Effective co-ordination may reduce conflict and assist in archiving and decision making (Emmitt and Gorse, 2003).

- **Communication** – The most significant challenge to virtual teams is the ability of team members to communicate non-verbally. In a team situation it is often non-verbal cues which convey most meaning; a wink, a raised eye brow, or an ear tug (Hoyt, 2000). These cues, whether created on purpose or accidentally, can give secret or subtle information about project or team dynamics (Cleland and Ireland, 2002). Because of the lack of actual physical face-to-face team interaction these non-verbal cues may be lost.

- **Decision Making** - Decisions in the construction industry are often needed immediately and rarely allow adequate time for all data and perspectives to be considered (Emmitt and Gorse, 2003). As a consequence decision-making by virtual teams is more difficult than when teams are co-located. This is because of the need to clarify positions from a variety of different locations. Industry case

studies have shown that for decision making in a virtual team, there needs to be on going virtual training (Kirkman et al., 2002).

TEAM SKILLS IN A VIRTUAL CONTEXT

Team skills are those which are held by team members that affect the performance of a team in which an individual is currently working (Salas et al., 2000). The dominant issues in team skills are summarised in Table 2 below and then discussed.

Table 2. Generic team skills and definitions

Generic Team Skill	Definition
Dealing with Issues of Trust	Ability to foster trust between team members. Especially in early stages of team development.
Dealing with Cultural Issues	Culture may be defined as the values, beliefs and ideals held by a group of individuals. Skills are needed to ensure that team members do not conflict on this cultural level.
Archiving	An ability to archive is important for collaboration as it allows members to revisit conversations and decisions made during past team interactions.

Computer mediated communication does not have the infrastructure to support all interactions and cues that convey trust between members of a team (Jarvenpaa and Liedner, 1998; Riedlinger et al., 2004). Because of the highly complex nature of virtual teams and networked organisations trust is a necessity (Lipnack and Stamps, 2000; Mohamed, 2003).

Team members may differ significantly in terms of cultural (i.e. values, beliefs and ideals) alliances, especially if the team members operate in different countries, or organisations. Possible solutions to these issues were identified in Kayworth and Leidner's (2000) study which highlighted strategies for dealing with cultural issues including attempts to: build skills in cultural awareness in virtual team members, and form virtual teams with members from complementary cultures.

An ability to archive is important for collaboration as it allows members to revisit conversations and decisions made during past team interactions. Records of construction meetings frequently take the form of minutes. These often result in lost data because of inaccurate recording methods or individual agendas. This can result in a need to go over 'old ground' in future meetings (Emmitt and Gorse, 2003).

DESIGN TEAM ACTIVITY

Research by Lawson (1997) identified collaboration as a large component of designer's working time and there has been a move toward applying research methods to gain a better appreciation of this activity and the skills required to effectively participate in collaborative design processes. In the process of gaining an understanding of design team activities Muir (1995) defined collaboration as, *"…an activity of communication between parties involved on a project"*.

Stempfle and Badke-Schaub (2002), and Gay and Lentini (1995) have both proposed models of design team activities. These models are similar to the early design process defined in Thorpe's (2004) Construction Process Protocol. All three models are now summarised in Table 3. They allow us to understand that design and more importantly collaborative design, is a segmented process, punctuated by 4-5 stages that define design processes. A link between these models would suggest that there is a possibility of establishing protocols for design team collaboration.

Table 3. Table of design activities and processes as adapted from Stempfle and Badke-Schaub (2002), Gay and Lentini (1995), and Thorpe (2004).

Design Process (Stempfle and Badke-Schaub, 2002)	Design Activities (Gay and Lentini, 1995)	Construction Process Protocols (Thorpe, 2004)
Planning	Orientating	Demonstrating the need (Phase zero)
	Subdividing the problem	Conception of need (Phase one)
	Establishing roles	Outline feasibility (Phase two)
Analysis	Information seeking	Substantive feasibility study and outline financial authority (Phase three)
	Information sharing	Outline conceptual design (Phase four)
Evaluation	Monitoring	Full conceptual design (Phase five)
Decision	Negotiating/ understanding	Coordinate design, procurement, and full financial authority (Phase six)
	Designing	Production information (Phase seven)
Control	Building	Construction (Phase eight)
	Evaluating	Operation and maintenance (Phase nine)

There is a difference between types of problems in design, well-structured (defined and understood) versus ill-structured (less understood, larger ramifications) (Perry and Sanderson, 1998). Ill-structured problems require longer periods of communication and the use of a range of artefacts (Perry and Sanderson, 1998). The early design process is an iterative form of problem solving, whereas solutions are formed and constantly revised or redefined to bring to light a satisfactory product (Lahti et al., 2004).

To be effective design team participants and designers, in virtual environments, designers will require a skill set that extends beyond specific design skills. The skills required to manage teams working in virtual environments will also need reconsideration if they are to be contextualized in virtual environments. There currently exists a need to better understand the core skills which will be required by virtual design teams.

Literature describes differences in the skills used by team members between co-located and virtual teams in the early design stage, including:

- **Leadership** – Leadership decides the balance of relevant skills and contributions from members to a project (Baird et al., 2000). The leader or leaders need to be able to create teams which identify the important 'social links' between virtual team members (Baird et al., 2000).

- **Co-ordination** - To obtain optimal results when designing collaboratively through a virtual medium, co-ordination and structuring skills need to be active in the early design period (Lahti et al., 2004). Lahti et al's (2004) study also highlighted the ability of the team members to discuss design in a virtual context. The ability to communicate ideas by making changes to others designs online was not available to their participants; essentially the communication was through a web chat system and email. They felt that not having this virtual aspect somewhat hindered the ability of the design students to communicate ideas.

- **Feedback** - Due to the ill-structured nature of early design processes, an ability to provide feedback is an important skill for team members to possess, particularly vertical communication channels between junior team members and senior decision makers (Baird et al., 2000). An ability to give feedback is crucial at this point because large amounts of information must be validated before progressing the design (Baird et al., 2000).

- **Communication** - Within Baird et al's (2000) study of collaborative engineering design some interesting communication processes were identified. An ability to build interpersonal relationships in an engineering team can be a slow process in terms of when a junior engineer has the privilege to interrupt a senior, termed 'permissions'. However, in the distributed team this process is yet again more slow (Baird et al., 2000). Depending on the relationship, a design engineer may need to contact another engineer regarding a necessary task but may delay this communication until the task is "*…urgent and unavoidable.*" (Baird et al., 2000). In Baird et al's (2000) findings it was suggested that the virtual environment may not foster skills such as feedback to enable necessary communication between members. If an intranet is used within a design organisation the links between members should be mixed so as to strengthen weak social connections to provide more clear communication channels.

- **Non-verbal communication** - In Baird et al's (2000) engineering examples, senior engineers are referred to as 'consultant engineers'. Skills in communication, particularly non-verbal, were important for consulting engineers providing feedback to juniors on their suggestions including smiles, nods and frowns (Baird et al., 2000). An ability to utilise these non-verbal cues would be severely impaired in the virtual environment. As yet it is unclear whether video media or use of extremely rich and detailed language could convey these cues in a virtual environment.

- **Interpersonal relationships** - The way in which team members collaborate during the early stages of design can impact on a team's ability to form a satisfactory product. Social collaboration appears to play an important part in the design process especially when researching and determining limitations in the early design processes.

- **Team skills** - Trust is not easily created in a computer mediated environment, especially when team members have had no prior experience with other members (Jarvenpaa and Liedner, 1998). What is suggested is that the early

stages of a design project are conducted in a co-located setting until trust is formed. Virtual teaming may then begin (Jarvenpaa and Liedner, 1998).

CONCLUSIONS

In order to function efficiently and effectively in a team environment, irrespective of whether it is a traditional or virtual team, team participants require 'appropriate skills' (i.e. awareness, understanding, abilities to apply). One cannot '*assume*' that all team members automatically possess all necessary skills. Previous research, as discussed in this paper, has identified that the introduction of new technologies can impact, both positively and negatively, upon the performance of teams. Therefore the ability to map and measure skills of individuals and teams, leading to training in any deficient areas identified, is seen as critical. Skills development and training should be viewed by management as an investment in creating more valuable and skilled employees. Development of skills mapping and measurement tools will be the major outcome of this aspect of the research project. Having identified key issues and critical skills, from the literature reviewed to date, the next phase of the project will take the first of a series of steps by developing a framework for analysis of design team activity, categorising activities and skills.

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