Title:
A Socio-Technical View at the Conceptual Design Knowledge Sharing

Authors:
Light Zaglago, light.zaglago@uwe.ac.uk, University of the West of England
Eric Yeboah-Asiamah, eyasiamah@gmail.com, University of Ghana Business School, Accra.

Keywords:
Tacit knowledge (TK), design-automated system (DAS), social technical

DOI: 10.14733/cadconfP.2018.427-431

Introduction:
New challenging business are characterised by globalization, dynamism and increasing levels of complexity due to rapid changes in technology and its connected intricate knowledge. Design automated systems (DAS) have created new opportunities for rapid access to information worldwide which is critical to development of new products. The global investment in technology has been valued at US$3.5 trillion with yearly expansion and it's interesting to note that, product design companies that have consistently applied technology design as a tool for knowledge sharing (KS) have outperformed their competitors per the UK Design Council and the Cox Review [2]. In the case of UK manufacturers, an estimated £10bn are invested on product development and design underscoring the need for appropriate technologies for product design and subsequent knowledge sharing [13]. Per [26] DAS objective of supporting multidisciplinary integration and sharing of knowledge at the conceptual phase of the design process is limited. There is desperate need of an integrated design tool and environment that can boost resolutions at an early stage in the conceptual design process. This integrated design tool should empower designers to accomplish consensus of design intent under complex design necessities and better design constraints. This paper attempts to understand both the social and technical enablers from a socio-technical perspective. This article begins with brief review of literature on key prior studies on design and tacit knowledge that have informed this research. The next sections outline the summary of adopted research methodology for the study. Data analysis and results follows with discussion and implications and conclusion and recommendation presented in the last section.

Design Communication and Tacit Knowledge:
The knowledge of the design requirements and constraints during this early phase of a product's life cycle is frequently indefinite and inadequate, making it difficult to employ computer-based systems [19]. Critical stages of design process, such as dealing with ill-defined problems entail some level of the face- to-face interaction [7]. The most knowledge to be shared is tacit, or embodied in practice and routines and thus non-coinable only a small part of our knowledge is explicit [11]. Designers have a creative vocabulary, which has rich meanings in design communication and they often make presentations and advance collaboration between team members through storytelling [10]. The idea of a shared vocabulary of design cannot in any context be strictly defined. Designers frequently use indexical expressions when communicating which cannot be used outside the context in which they originated without changing their meaning [10]; [19].

Teams often repeat past mistakes in design results since they lack episodic knowledge of errors that might have been made in the past. Team members normally lack an understanding of the critical design factors affecting areas other than their own. Lack of a mutual vocabulary and insufficient

knowledge of functional areas that do not fall under a designer's domain can obstruct the advancement of co-evolved understanding and consensus during design process [24]. It is difficult to unusually infer the features of design specifications and artefacts descriptions without comprehending the social state in which they were generated. Again, shared objects are integral to design communications, which form part of depictions constructed via frequent communication and cooperation regarding design options and tentative ideas. By concentrating on technology, the human and team aspects are ignored. Research has validated that design KS initiatives, which have focused entirely on technology solutions in endeavoring to manage tacit design knowledge, have consistently been shown to meet with limited success [27].

It was established by [5] that while it is important to structure and organize data for easy retrieval and reuse, it is also important to understand that neither the mind of the designer nor the process of design ideation follows a particular structure or sequence. Understanding design-cognitive perspective is rapidly becoming an important area, which may provide answers that would drive the next-generation computational support tools [5]. The determination to automate knowledge regarding design engineering have been challenging since most are cognitive features such as, tasks that require judgment inherent difficulty of hand- eye skilled tasks, subtlety or common sense, and the breadth of TK. A determination to create technology systems based on TK have not yielded the needed result, human interaction is required to capture expertise [25]. There is crucial need of an integrated design tool and environment that can enhance resolutions at early in stage conceptual design process [3]. This integrated design tool should enable designers to attain consensus of design intent under multiple design requests and improved design constraints. The design tool should permit the design team to observe more configurations at greater levels of detail [4]. Nevertheless, future technology progress is expected to increase accommodating human dimension share of TK better than before. This is where current social web tools might be partially helpful.

The socio-technical perspective thus adopts a holistic approach, which highlights the interweaving of social and technical factors in the way knowledge sharing work. It also underlines the complex interactions, which take place between the subjective perceptions of design engineer and the objective characteristics of design processes. The implication of socio-technical analysis is needed to seek the joint optimization of the social and technical subsystems within the product design organization [18]. This paper highlights multi-level context for the effective assimilation of Knowledge sharing in product design organization. This will provide managers with improved understanding and guidance on how to handle the relationship between TK and technology knowledge. The main contribution of this research is the discovery of complex interactions through a socio-technical perspective on Knowledge sharing at conceptual at shown in figure1.The paper examines details on how problems with technology knowledge sharing and need for tacit knowledge sharing (TKS).

Research Methods:

This study utilizes a mixed sequential explanatory survey method. The survey questionnaire design was based on the extant literature. The subject unit of survey analysis was a design team member in UK who has been a member of product design ranging managers to engineers. The questionnaires were pilot tested between March and April 2015 with the full survey starting mid-April to mid-October 2015. 800 questionnaires were administered, 300 were administered by post, and 500 were delivered electronically and the response rate was 22.8%. Qualitative data was collected (26 interviews) from eight product design teams using DAS technology. The sizes of the product design teams ranged between 5 to 10 members. The interviews followed a conversational style, with focus on obtaining as much rich information as possible.

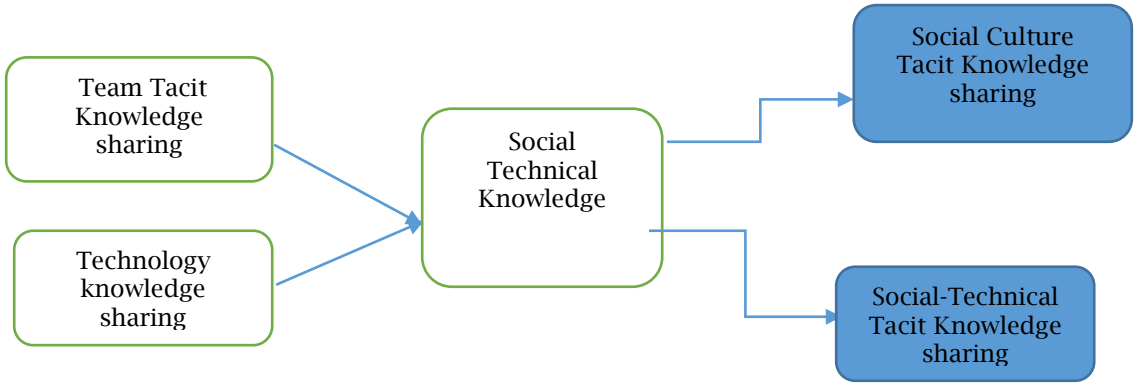

Fig. 1: Social and technical Knowledge sharing framework.

Result and Discussion:
The research further validates the preliminary findings of [1]; [9] and in a face-to- face team, [8] provided evidence demonstrating that design team members may interact through facial expressions, for example, body language, smiling, gestures and body language; which is limited by technology transfer [8]. Technology simply cannot share TK effectively with it riches [1]; [9]. On Contrary [25] established that, TK does not lend itself to technology because it needs human interaction to be shared. However, engineers' expert systems have endeavored to capture the TK of experts and create programs to share this knowledge with in organizations, which have not been entirely successful [25].

This research advanced that social interaction is a vital factor to the effective sharing of tact knowledge within design team. The argument offered above does not discount the use of technology for enhancing TK to share in design team. [20] posits that technology can enhance design engineers networking that enables teammates to share their own experiences through TK. Preliminary evidence in support of the earlier contention of [20] team combines DAS and face-to-face KS. Design team members can achieve success a balancing face-to-face interaction that occur among design team members and those interactions that are facilitated through technological means, although technology can be used to manage TK resources. [20] also argued that using technology for TKS no matter how sophisticated is only as useful as the content they carry. Furthermore, [20] endorsed the need for a clear and focused approach to technology that enables learning and social interaction in order to harness the value of TK shared. Continuous competitive advantage of design team can be sustained by creating an acceptability among technological systems and social systems. Technologies can be used to increase the efficiency of the design team members and enhance the flow of TK [12]; [4].

More importantly, the results support long held view that Technology positively influence design engineer perceived behavioral control towards KS [19]. Both technical and social factors are closely linked and impact each other in a manner that may not always be expected from an assumption of rationality [6] [14]. DAS Technology system cannot replace the direct face-to-face rather facilitated communication or a prerequisite for the effective TKS [23];[15]. Even though TK generation is very critical through face-to-face and the human interaction, the technology was evidently playing the important role of connecting the individual's engineers sometimes. The empirical evidence from this research thus provides support for these assertions by demonstrating that there is an association between team social culture tacit, DAS-TK (social- technical knowledge), were significant and positive, as expected, was significantly correlated

Research Implications:
This study has some practical inferences for management. There is need for Managers to adopt strategies that enhance effective TKS and various orientations of learning. There is massive economic

value and potential in leveraging TK in product design organizations. This study provides managers an in-depth view about team TKS and KS in managing, implementation and mitigating barriers to TKS especially in conceptual stage of product design. Mostly teams are formed based on technical expertise. The scales developed in the study can be adapted in formation, training and appraising of the design team-by-team managers. The results of the study show that technology is vital factor to engage in TKS. Organizations should support KS technology by engaging appropriate technology systems that are flexible and investing in the most efficient technology.

Conclusion:

The research revealed that design KS in a team is an intricate process. KS cumulating in the discussion on technology concludes that, though technology is vital to KS undertaking, there is the need to combine it with social culture dimensions, which are the viable success for conceptual design. Socio-technical approach is suggested since DAS is limited for the effective transfer of TK as, hence the need to explore at the social cultural dimension of KS. An equal emphasis on technology knowledge (explicit) and TK might help to provide the answers to this challenge and help management to identify the facilitating and inhibiting factors, which influence the success of Knowledge Management in new product design organization.

References:

[1] Al-Alawi, A.I.; Al-Marzooqi, N.Y.; Mohammed, Y.F.: Organizational culture and knowledge sharing: critical success factors, Journal of knowledge management, 11(2), 2007, 22-42. https://doi.org/10.1108/13673270710738898

[2] Bell DeTienne, K.; Dyer, G.; Hoopes, C; Harris, S.: Toward a model of effective knowledge management and directions for future research: Culture, leadership, and CKOs, Journal of Leadership and Organizational Studies, 10(4), 2004, 26. https://doi.org/10.1177/107179190401000403

[3] Bouncken, R.; Brem, A.; Kraus, S.: Multi-Cultural Teams as Sources for Creativity and Innovation: The Role of Cultural Diversity on Team Performance, International Journal of Innovation Management, 20(01), 2016, 1650012. https://doi.org/10.1142/s1363919616500122

[4] Calkins, D.; Egging, N.; Scholz, C.: Knowledge-Based Engineering (KBE) Design Methodology at the Undergraduate and Graduate Levels, Development, 1999, 21.

[5] Chandrasegaran, S.K.; Ramani, K.; Sriram, R.D.; Horváth, I.; Bernard, A.; Harik, R.F.; GAO, W.: The evolution, challenges, and future of knowledge representation in product design systems, Computer-aided design, 45(2), 2013, 204-228. https://doi.org/10.1016/j.cad.2012.08.006.

[6] Erhardt, N.L.; Dynamics in team-based knowledge work: understanding processes and media use, Rutgers University-Graduate School-New Brunswick, 2008.

[7] Fischer, G.: Social creativity: turning barriers into opportunities for collaborative design, ACM, 2004, 152-161.

[8] He, J.: Examining Factors That Affect Knowledge Sharing and Students' attitude Toward Their Learning Experience within Virtual Teams, University of Central Florida Orlando, Florida, 2009.

[9] Ivankova, N.V.; Creswell, J.W.; Stick, S.L.: Using mixed-methods sequential explanatory design: From theory to practice, Field methods, 18(1), 2006, 3-20. https://doi.org/10.1177/1525822x05282260.

[10] Larsson, A.: Making sense of collaboration: the challenge of thinking together in global design teams. ACM, 2003, 153-160. https://doi.org/10.1145/958160.958184.

[11] Matzler, K.; Renzl, B.; Müller, J.; Herting, S.; Mooradian, T.A.: Personality traits and knowledge sharing, Journal of Economic Psychology, 29(3), 2008, 301-313. https://doi.org/10.1016/j.joep.2007.06.004 .

[12] Mayfield, R.D.: Organizational culture and knowledge management in the electric power generation industry, ProQuest, 2008.

[13] McLaughlin, P.: Manufacturing best practice and UK productivity. Future of Manufacturing Project, Evidence Paper, 2013, 21.

[14] Moum, A.: Design team stories: Exploring interdisciplinary use of 3D object models in practice, Automation in Construction, 19(5), 2010, 554-569. https://doi.org/10.1016/j.autcon.2009.11.007 .

[15] Kodama, M.: Boundaries innovation and knowledge integration in the Japanese firm. Long Range Planning, 42(4), 2009, 463-494. https://doi.org/10.1016/j.lrp.2009.08.001 .
[16] Moultrie, J.; Livesey, F.: Measuring design investment in firms: Conceptual foundations and exploratory UK survey, Research Policy, 43(3), 2014, 570-587. https://doi.org/10.1016/j.respol.2013.08.005 .
[17] Pan, S.L.; Leidner, D.E.: Bridging communities of practice with information technology in pursuit of global knowledge sharing, The Journal of Strategic Information Systems, 12(1), 2003, 71-88. https://doi.org/10.1016/s0963-8687(02)00023-9 .
[18] Pan, S.L.; Scarbrough, H.: A socio-technical view of knowledge sharing at Buckman Laboratories, Journal of knowledge management, 2(1), 1998, 55-66. https://doi.org/10.1108/eum0000000004607 .
[19] Panahi, S.; Watson, J.; Partridge, H.: Social media and tacit knowledge sharing: developing a conceptual model, World academy of science, engineering and technology, (64), 2012, 1095-1102.
[20] Panahi, S.; Watson, J.; Partridge, H.: Towards tacit knowledge sharing over social web tools, Journal of knowledge management, 17(3), 2013, 379-397. https://doi.org/10.1108/jkm-11-2012-0364 .
[21] Red, E.; French, D.; Jensen, G.; Walker, S.S.; Madsen, P.: Emerging design methods and tools in collaborative product development, Journal of Computing and Information Science in Engineering, 13(3), 2013, 031001. https://doi.org/10.1115/1.4023917 .
[22] Samarah, I.M.: Collaboration technology support for knowledge conversion in virtual teams, Southern Illinois University at Carbondale, 2006.
[23] Tiwana, A.; Ramesh, B.: A design knowledge management system to support collaborative information product evolution, Decision Support Systems, 31(2), 2001, 241-262. https://doi.org/10.1016/s0167-9236(00)00134-2 .
[24] Trinkle, S.I.: The nature of tacit knowledge and the nature of the expert Tacit knowledge retention at the Tennessee Valley Authority, Capella University, 2005
[25] Verhagen, W.J.; Bermell-Garcia, P.; van Dijk, R.E.; Curran, R.: A critical review of Knowledge-Based Engineering: An identification of research challenges, Advanced Engineering Informatics, 26(1), 2012, 5-15. https://doi.org/10.1016/j.aei.2011.06.004 .
[26] Wang, L.; Shen, W.; Xie, H.; Neelamkavil, J.; Pardasani, A.: Collaborative conceptual design—state of the art and future trends, Computer-aided design, 34(13), 2002, 981-996. https://doi.org/10.1016/s0010-4485(01)00157-9 .
[27] Wang, S.; Noe, R.A.: Knowledge sharing A review and directions for future research, Human Resource Management Review, 20(2), 2010, 115-131. https://doi.org/10.1016/j.hrmr.2009.10.001 .