Global Teamwork:

Components of Engaging and Productive Meetings

Maria Frank[1], Renate Fruchter[2], Marianne Leinikka[3]

[1] M.Sc., Ph.D. Candidate, Civil and Environmental Engineering, Stanford University, mfrank0@stanford.edu

[2] Dr., Dipl.-Eng., ASCE Member, Director of Project Based Learning Laboratory (PBL Lab), Civil and Environmental Engineering, Stanford University, fruchter@stanford.edu

[3] Researcher Finnish Institute of Occupational Health FIOH, marianne.leinikka@ttl.fi

Abstract

Global teamwork has become standard practice in design and construction industry. This paper presents preliminary findings from an on-going study aimed to determine what components of distributed meetings contribute to engagement and stress in global learners. We build on literature from psychology, education, and communication to understand the hidden cognitive demands of global learners in interaction. The data presented in this paper was collected from the 2014 and 2015 student cohort who participated in the sixteen-week long architecture, engineering, construction (AEC) Global Teamwork course offered in the Civil and Environmental Engineering Department and run by the PBL Lab at Stanford with partners worldwide. We collected data from 34 students distributed in 5 teams during their weekly two-hour project meetings. This is an ongoing research project and data collection continues in 2016 and additional data from 41 students is generated. We took an inductive approach integrating qualitative and quantitative methods for date analysis. The paper presents a compilation of cross-disciplinary AEC student team meeting interactions with the associated work and cognitive load and its relation to team engagement and productivity during their weekly project meetings. The paper discusses preliminary findings related to: interaction participation, artifact usage, discipline topics, and interaction type. The findings indicate that more complex meetings, with more inter-disciplinary exchange using supportive artifacts results in higher engagement during the meeting.

Keywords: Collaboration, Engagement, Meeting Management

1. INTRODUCTION

Multi-national projects and global teamwork have become the norm in STEM education and the construction industry (Anabari 2010; Thomas 2005; Fruchter 2003; Bartlett 2002). The term 'global team' is herein defined as a globally distributed, culturally diverse, often interdisciplinary group of people who collaborate virtually using Information and Communication Technologies (ICTs). Global teams face five challenging discontinuities: space, time, discipline, culture, and technology that stress global learners. The distributed nature of collaboration poses special challenges on cognitive capacities, (Fruchter & Ponti 2010) which have yet to be studied. There is still more to learn about how the discontinuities influence meeting activity and their cognitive load in higher STEM education (Ochieng 2010).

The global teams collaborate on a regular basis and team meeting management studies seek new ways to increase meeting engagement. Increasing engagement in meetings and productive time has been a research topic, aiming to characterize effective meetings mainly from qualitative field observation. This paper explores a new way to understand and characterize what a productive meeting is. Activity in and complexity of meetings require mental resources that cause a depletion of cognitive resources. Hence, meeting activity cannot fully be understood without looking at this cost and the Fatigue it causes (Kinnunen et al. 2013, Schellhammer et al. 2013, Gajewski 2010, Le Blanc 2008, Parayitam et al. 2007, Le Fevre 2003, Crowe et al., 2003, Schooler and Mulatu, 2001, Sadri 1997, Christensen and Mackinnon, 1993). Cognitive processes to execute activities create a cognitive load or workload (Cooke et al. 2012, Haapalainen et al. 2010, Plass et al. 2010). Cognitive load or workload is understood as a participant's invested effort to achieve a specific performance. It results from the requirements of a task, as well as the participant's inherent characteristics related to the task, such as skill, behavior, perception, and engagement (Hart, Staveland 1988).

Cognitive load research has a long history of applying questionnaires to evaluate perceived load (Söderström et al. 2004, Rubio et al. 2004). Mental Fatigue as a result of cognitive load causes a decrease in cognitive flexibility and hence productivity. Cognitive flexibility is the ability to switch between modes of thought and simultaneously think about multiple concepts (Leinikka et al. 2014). It is an essential part of adaptive behavior, such as flexible everyday functioning and learning (Boger-Mehall 1996). Cognitive flexibility is often evaluated through task switching exercises as an indicator of cognitive control (Vandierendonck 2010, Arbuthnott 2000, Jersild 1927, Spector & Biederman 1976). There is a lack of research on the relationship between cognitive Fatigue as indicator of meeting success in learning environments, as well as understand learner and knowledge worker engagement in real life settings over an extended period of time.

In this learning and distributed teamwork context, project progress is achieved through collaborative activities and joint work effort. It is important to understand the individual's cognitive load (Haapalainen et al. 2010) and flexibility as a team characteristic. This paper presents a new approach to evaluate learners' team activity through evaluating its fatiguing effect in the context of behavior and structure of meetings. We use insights from cognitive psychology to improve the understanding of meeting engagement and thereby productivity.

2. METHODOLOGY

2.1 The Project

The architecture, engineering, construction (AEC) Global Teamwork course is used as a testbed. It is based on the project-based learning (PBL) methodology that focuses on problem based, project organized activities that produce a product for a client, using processes that bring people from multiple disciplines together. It engages faculty, practitioners, and students from different disciplines, who are geographically distributed. It is a two quarter course that engages architecture, structural engineering, building systems MEP engineering, life cycle financial management (LCFM), and construction management (CM) students from universities in the US, Europe, and Asia (Fruchter, 2006).

A building project is the central AEC teamwork activity. The project is based on a real university building project that was scoped to address the academic time frame and pedagogic objectives. The project specifications include: (1) size of university building; (2) location of building site in disaster zones, (3) a budget, and (4) a time for construction. The project progresses from concept development in winter quarter to project development in spring quarter. Each AEC global student team held weekly 2-hour project meetings using one of two online collaboration platforms – web-conference with application sharing capabilities (GoToMeeting offered by Citrix), and immersive virtual world collaboration environment (TERF offered by 3D ICC Inc.).

2.2 Data Types

We collected and used two data sources for this study: (1) a cognitive flexibility game measuring cognitive flexibility and Fatigue as dependent variable, (2) meeting recordings of the interaction context.

2.2.1 Quantitative data from the cognitive flexibility game

The cognitive flexibility game is based on a task switching exercise, which is a standardized tool to measure cognitive control and flexibility. It provides insight into participant's cognitive load and capacity in different situations. The task that is used for this study is a modified three-phased version of a number-letter task. (Vandierendonck et al. 2010, Monsell 2003)

The test utilizes a defined subset of Arabic numbers (2-9) and Latin letters (a, e, g, i, k, m, r, u) that are commonly used in the Anglo-American, German, Hispanic, and Fenno-Ugric language groups. Bivalent letter-number pairs (e.g. a7) (Vandierendonck 2010, Monsell 2003, Cepeda 2001, Meiran, 2000a, Rogers and Monsell 1995, Jersild 1927) are presented to the participant either above or below a stationary horizontal line. To avoid the possibility of the participants fixating on a certain location a horizontal jitter is used. The responses are given from the keyboard by pressing either the X or M key. The specific response letters are on similar locations across a variety of keyboards.

The cognitive game has two tasks: categorization andtask-switching. At the end of each task, the mean value of reaction time and the percentage of correct answers is shown to the participant as a performance feedback.

In the categorization task, letter-number pairs are presented above the horizontal line. The task is to categorize the number of the pair as either odd or even by pressing X or M, respectively. Thereafter, stimulus pairs are presented below the horizontal line and the task is to categorize the letter of the pair as either consonant or vowel by pressing

X or M, respectively. The letter-number pairs are quasi-randomized so that an equal amount of each letter and number will appear but in randomized pairs of all possible combinations.

In the task-switching activity the participant performs both categorization tasks in short alternation. The letter-number pairs alternate between above or below the horizontal line. The task changes according to the location cue: when the letter-number pair is presented above the horizontal line, the task is to classify shown numbers as odd or even. When the pair is presented below the horizontal line, the task is to classify the letter of the pair as consonant or vowel, by pressing either X or M, respectively.

In the categorization and the task-switching tasks, the letter-number pairs are presented until the participant responds or for a maximum of 2500 ms. The rate of stimulus presentation is tied to the participant's responses in the following way: The successive stimulus is presented 150 ms after a correct response, and 1500 ms after an incorrect or missed response. Key presses occurring between 40 ms and 2500 ms from the stimulus onset are accepted as responses (Leinikka et al. 2013).

The reaction time is used as main analytics from the task-switching task and is defined as the time between stimulus and correct response measured in milliseconds (Allport et al. 1994, Meiran 1996, 2000, Rogers and Monsell, 1995).

The cognitive flexibility game was played by the participants before the start (pre) and at the end (post) of their weekly two-hour project meeting. The difference between the pre and post condition, and thereby the relative change of cognitive flexibility, build the basis of the investigation of this paper.

2.2.2 Qualitative data from video protocol analysis of meeting recordings

Weekly team meetings were recorded, transcribed, and coded based on the constant comparative method by Strauss and Corbin (1990). The coding method followed the approaches introduces by Hay (2005) and Fruchter and Courtier (2011). Coding themes are: 1) talk/no-talk, 2) discipline topic related to the five disciplines of the project, 3) artifacts such as plans, pictures, documents, etc. and 4) interaction type, e.g. brainstorming, problem solving, presentation, and negotiation. Through the iterative process these categories were created and further developed. The aim of the coding is to interpret the dynamics of cross-disciplinary team interaction.

2.3 Participants

The testbed of this study was the 2014 and 2015 AEC Global Teamwork project based learning (PBL) course offered by the PBL Lab at Stanford University (pbl.stanford.edu). We invited students to volunteer for the study. We present the preliminary analysis and findings of 34 participants and 5 teams out of the two data collection sets from 2014 and 2015. The considered participant sample consisted of 13 women and 21 men, of which 14 were Stanford students and 20 were distributed partner universities in the USA and Europe. The schedule allowed for observation of the distributed teams during 2-hour long weekly online meetings over a 4 months' period. The study is ongoing and additional data from 41 students in 2016 is being collected.

To date, fourteen meetings of the 5 teams were transcribed and coded. These meetings were coded for Talk/No-Talk. 10 meetings were coded for all context aspects investigated. The transcripts generated a total of 95 cases - 95 cases of talk/no talk and 31 context coded cases. A case consists of the coded data for one participant in one meeting. 54 cases of talk/no-talk and 31 context coded cases had a complete cognitive flexibility data set. These are the cases that were used for the analysis presented in this paper.

3 DATA ANALYSIS

This study uses a mixed methods approach combining qualitative methods including field observations with quantitative research methods such as statistical analysis on cognitive measurements. The methods were combined in an inductive manner. This allowed for a broader understanding of cognitive Fatigue as a consequence of activity in complex virtual global team work.

3.1 Cognitive flexibility measurement

The cognitive game reaction time values are corrected to exclude ambiguous switches that results in equal response whether it is the letter or number task. The cleaned data is used to calculate the difference of the cognitive task results pre and post meeting. This allows for an observation of change in cognitive flexibility and Fatigue as a result of cognitive load caused by the meeting. This difference is an indicator of the impact of a meeting engagement, causing cognitive load, on the individual cognitive state. Herein, we call this indicator reaction time difference. Following the arousal theory used in other studies (Yekelis & Reeves 2010) we look at the relative changes of the pre to post meeting cognitive flexibility rather than absolute values. Thereby we control for variations of the absolute values due to changes in participants' baseline Fatigue.

Cognitive flexibility is influenced by distraction in the background, exhaustion, or emotions such as frustration. However, the meeting activity following or preceding the cognitive flexibility game is influenced by similar factors that affect the ability to concentrate, focus, and be attentive. We are confident that the difference in cognitive flexibility pre and post meeting is a reliable measure to evaluate how meeting engagement affects cognitive load and flexibility; as we discussed in the previous work. (Cooke et al. 2012, Haapalainen et al. 2010, Gajewski 2010, Le Blanc 2008, Vandierendonck 2010, Arbuthnott 2000).

Due to the longitudinal nature of this study we calculate the temporal change in switching-cost, the main indicator of learning effects. Switch-cost is the difference between reaction time in a repeated task and reaction time after a task-switch. Longitudinal linear mixed effects models, lmer (R- lme4 package), are used to analyze the learning effect. Time trends were analyzed on a monthly time scale of the meetings for the 4 month of data collection as well as on an hourly time scale for the 2-hour meeting time. The lmer models control for the participant to accommodate individual differences in changes of switch-cost across the measurements.

3.2 Mixed methods analysis

The coded transcripts were used to generate statistics of code occurrences. The occurrences are calculated as per cent of meeting time a specific code was applied. This numeric qualitative evaluation serves to generate meeting patterns. These patterns are used as independent variables in a multiple regression with the difference of reaction time as cognitive flexibility data as dependent variable. This approach is used to gain insights on the effect of various meeting parameters on the cognitive load of meeting participants.

4 RESULTS AND DISCUSSION

Past research has shown that higher engagement causes higher cognitive load, higher cognitive load causes higher Fatigue, and higher Fatigue lowers cognitive flexibility. Following this argument, this study compares cognitive flexibility measured pre and post virtual meeting to understand engagement levels during the meeting that change Fatigue. The hypothesis is that the measured cognitive flexibility will be higher at the beginning of a meeting than at the end as a result of experienced cognitive load. Hence, participants will have slower reaction times and less correct hits post meeting. The collected data, however, shows a fluctuation in Fatigue levels as a result of meeting activities. Surprisingly, for some of the meetings some participants had better cognitive flexibility after the meeting than before. We coined this phenomenon *AfterGlow* (Frank et al. 2015). Herein, an increase in participants' cognitive flexibility post meeting will be called *AfterGlow*, and a decrease in participants' cognitive flexibility post meeting will be called Fatigue. We recorded a total of 41 *AfterGlow* results and 13 Fatigue results.

Figure 1 shows the cognitive flexibility data as reaction time difference, Fatigue and *AfterGlow*, for all transcribed meetings for one of the teams- Team1. Team1 represents a typical AEC team in the class. We chose four meetings to represent the two project phases that all teams experience in the class - the conceptual design phase - Meeting2, Meeting3, and the project development phase -Meeting5, Meeting6. Green bars indicate *AfterGlow* and red bars show Fatigue on a scale of reaction time difference in milliseconds.

Figure 1: Cognitive flexibility data of Team1 for the participants in four meetings: two meetings from the conceptual design phase – Meeting2 and Meeting3; and two meetings from the project development phase – Meeting5 and Meeting6

The reaction time difference of the cognitive flexibility data was than correlated with the meeting context coding generated through the qualitative analysis to see significant influences. In this preliminary data analysis based on a first limited data set two variables of the coding yielded significant results. The amount of time spent on discipline related conversation- Architecture, Structural Engineering, Construction, Mechanical, Life Cycle- is statistically significantly negative correlated with *AfterGlow* and the reaction time difference ($r=-0.98$, $p<0.05$). This means that the more teams talked about non-work related topics the more likely they were to show *AfterGlow*. A possible explanation for this phenomenon is, that maintaining a social team atmosphere and allowing for brief social communication increases the engagement and enhances cognitive flexibility.

The second significant ($p<0.1$) results shows a positive correlation ($r=2.21$) between *AfterGlow* and team organization. This indicates that the more the teams actively organized and structured their meetings the higher the chance for *AfterGlow*. A possible explanation for this phenomenon is that the active organization helped teams to get on the same page and re-engage all team members into the meeting and thereby increase engagement and cognitive flexibility.

Two weakly significant results are detected related to the artifacts. Using more documents is positively correlated with *AfterGlow* ($r=4.068$, $p<0.1$) and sketching more is negatively correlated with *AfterGlow* ($r=-4.9$, $p<0.1$). This indicates that more sketching tends to go with more Fatigue in the teams and using more documents as shared references tends to increase *AfterGlow*. A possible explanation for this phenomenon is that sketching and creating lead to significant cognitive resource demands and hence increases Fatigue, whereas reference documents, that already have been created serve as cognitive support and thereby support *AfterGlow*.

The cognitive flexibility data of Meeting 6 differs from Meeting 2, Meeting 3, and Meeting 5 as illustrated in Figure 1, showing Fatigue for two of the participants. We further investigated what leads to the difference between the two extremes i.e. Meeting 6 and Meeting 2 (Figure 1). The statistical analysis created limited insights due to the initial small data set. This first step of comparing two example meetings allows us to gain some deeper qualitative insight into meeting context that fosters engagement and high cognitive flexibility or *AfterGlow*. Figure 2 illustrates the qualitative data context codes and their distribution in Meeting 2 and Meeting 6 of the Team1 team resulted from the video protocol analysis of the meeting recording.

The *Talk/No-Talk* code highlights how much a participant spoke during a meeting. T1 stands for a team member that was not a participant in the study and I1 stands for the main instructor of the project. The difference between the pie charts of the two meetings is that in Meeting 2 less participants were present and no instructor interaction occurred, whereas in Meeting 6 more team members were present and the instructor was involved in the interaction. A potential explanation for this pattern is that a smaller group (Meeting 2) can create higher cognitive flexibility in a less complex situation.

The *Discipline Topic* code shows that Meeting 2 consisted of a more balanced discussion of all disciplines, whereas Meeting 6 shows a heavier focus on one topic. The more interdisciplinary setting of Meeting 2 potentially enabled students to participate more both in terms of length and frequency, as well as stay engaged for longer periods of time and thereby create *AfterGlow*.

The *Interaction Type*, i.e. problem solving, co-creation, or exploration, distribution pattern of Meeting 2 shown in Figure 2 is heavily focused on exploration of ideas, problem solving, and co-creation, whereas Meeting 6 is on organization and presentation. That shows that Meeting 2 has a more creative and active context where participants feed off each other's engagement and create new material. This contributes to the observed *AfterGlow* for all participants. Meeting 6 however focused on team organization. This finding seems to contradict the initial statistical results. We plan to further investigate this phenomenon since there might be other factors that we did not code for.

The *Artifacts*, such as plans, images, sketches, distribution pattern show a main use of reference pictures, spreadsheets, and documents in Meeting 2 and displayed a balanced use of different artifacts. In Meeting 6 the team mainly used a model on screen of the building, even though other artifacts were integrated they had limited use. A potential interpretation of this data is that a more balanced and complex usage of artifacts has a positive effect on *AfterGlow* and engagement, whereas a strong focus on one artifact makes it more difficult to have prolonged engagement and thereby develop *AfterGlow*.

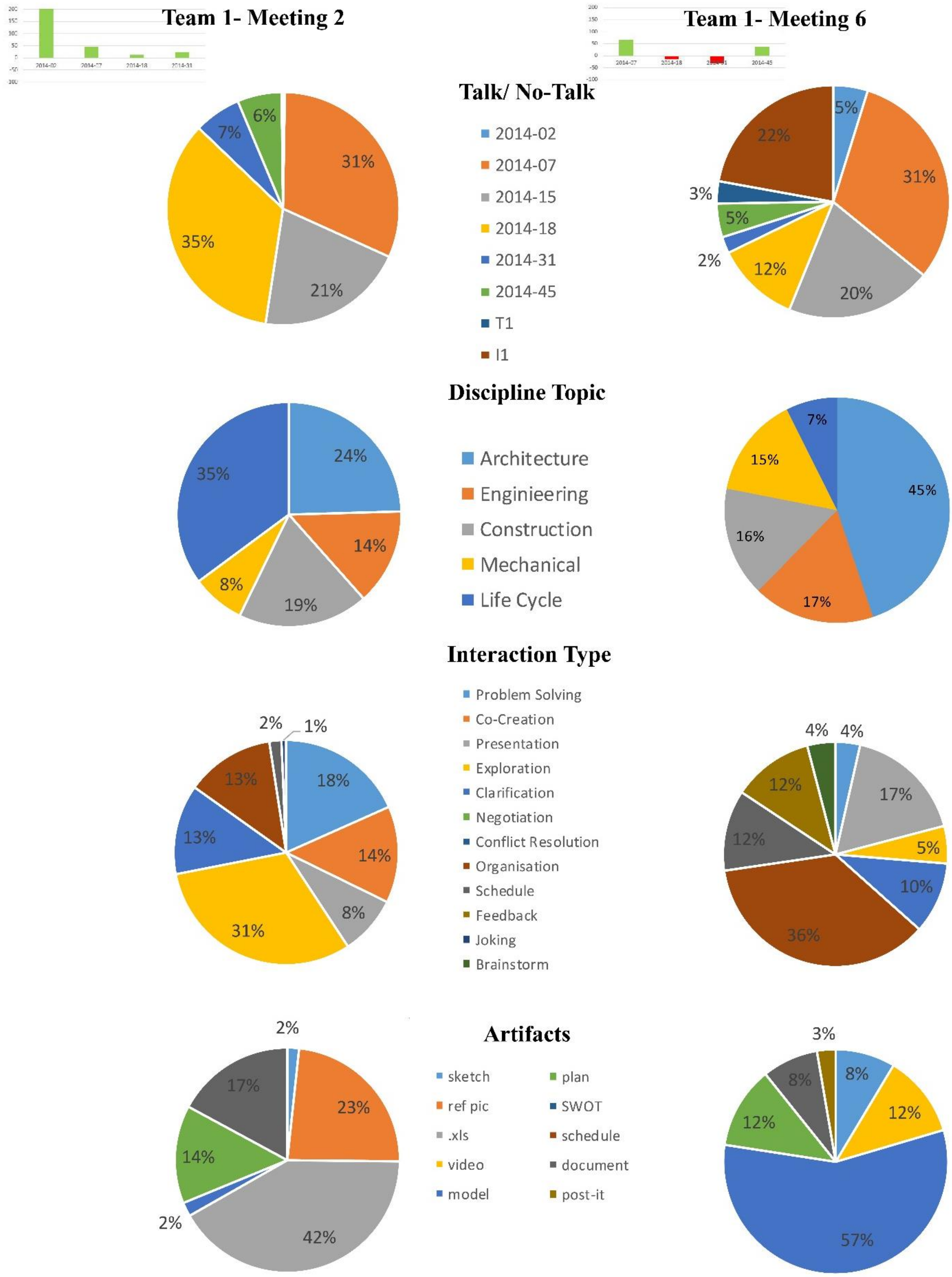

Figure 2. Overview of qualitative data coding patterns for Team1 Meeting 2 and Meeting 6

5 CONCLUSION

Cognitive flexibility is as valuable metric of cognitive load and engagement. It allows to evaluate engagement on an individual deep level, which prior observations and self-report studies could not identify. This introspective approach enables us to look at meeting interaction through a different lens and thereby identify relevant patterns of meeting context.

The statistical analyses indicate that social interaction during the project meetings enables teams to be highly engaged. This can be understood as either micro-relaxations that lower the cognitive load or as relationship building that enables team members to fully immerse into the meeting and create cognitive flexibility – the *AfterGlow*. The data furthermore shows that the usage of artifacts such as ad-hoc sketches and preexisting documents support collaboration, where using joint documents lowers cognitive load and supports the high engagement. The qualitative interpretation of the illustrated meeting data furthermore leads to the hypothesis that meetings where participants create more, participate in more diverse interaction types foster high engagement and increase cognitive flexibility.

These preliminary findings are based on a first data set collected bi-weekly that consisted of 34 participants that engaged in 14 project meetings. Since this is an ongoing NSF sponsored study, data collection continues during the 2016 AEC Global Teamwork course. This additional data from 41 students in 2016 is being collected weekly, which significantly increases our data set and enables further validation of the Afterglow phenomena. Extrapolation of the research findings to industry meetings may be influenced by the presence and role of an instructor in this project-based learning education testbed. Nevertheless, we envision that a facilitator could contribute and impact the team dynamics in a corporate setting. All of the participants in this study were highly competitive and engaged students. This may create a more engaged interaction than many regular teams experience. Further data analysis of the larger data sets collected in 2015 and 2016 will provide a comprehensive statistical evaluation of patterns in the data. On-going in depth statistical analysis of the data may yield new correlation between the meeting context and participants cognitive fatigue due two cognitive load or *AfterGlow* as a result of high engagement.

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REFERENCES

Anabari, F. T.; khilkhanova, E. V.; Romanova, M. V.; Umpleby, S. A.: Cross cultural differences and their implications for managing international projects.

Arbuthnott, K.; Frank, J. (2000): Trail Making Test, Part B as a Measure of Executive Control: Validation Using a Set-Switching Paradigm. In Journal of Clinical and Experimental Neuropsychology (Neuropsychology, Development and Cognition: Section A) 22 (4), pp. 518–528.

Bartlett, C. A.; Ghoshal, S. (2002): Managing Across Borders. the transnational solution. 2. Edition. Boston, Massachusetts: Harvard Business School Press.

Boger-Mehall, S., Cognitive Flexibility Theory: Implications for Teaching and Teacher Education PROCEEDINGS Society for Information Technology & Teacher Education International Conference, 1996 Publisher: Association for the Advancement of Computing in Education (AACE), Chesapeake, VA

Cooke, N. J.; Amazeen, P. G.; Gorman, J. C.; Guastello, S. J.; Likens, A.; Stevens, R. (2012): Modeling the Complex Dynamics of Teamwork from Team Cognition to Neurophysiology. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting 56 (1), pp. 183–187.

Crowe M, Andel R, Pedersen NL, Johansson B, Gatz M. (2003) Does participation in leisure activities lead to reduced risk of Alzheimer's disease? A prospective study of Swedish twins. Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2003; 58:P249–P255.

Frank, M., Fruchter, R., and Leinikka, M. (2015) "High engagement decreases fatigue effect in global learners," SAVI Symposium on New ways to teach and learn for student engagement, Stanford University, April 2015

Fruchter, R.; Ponti, M. (2010) Distributed attention across multiple social worlds, AI and Society, 25 (2): 169-181

Fruchter, R.; Townsend, A. (2003): Multi-Cultural Dimensions and Multi- Modal Communication in Distributed, Cross-Disciplinary Teamwork. In International Journal of Engineering Education 19 (1), pp. 53–61. Available online at http://www.ijee.ie/articles/Vol19-1/IJEE1346.pdf, checked on 8/24/2012

Fruchter, R., (2006) The Fishbowl: Degrees of Engagement in Global Teamwork, in Intelligent Computing in Engineering and Architect, I. Smith ed., LNAI, Vol. 4200, Springer Verlag, 241-257.

Gajewski, P. D.; Wild-Wall, N.; Schapkin, S. A.; Erdmann, U.; Freude, G.; Falkenstein, M. (2010): Effects of aging and job demands on cognitive flexibility assessed by task switching. In Biological Psychology 85 (2), pp. 187–199.

Haapalainen E., Kim S. J., Forlizzi J. F., Dey A. K. (2010): Psycho-Physiological Measures for Assessing Cognitive Load. Conference Paper. Copenhagen, Denmark, 9/26/2010, checked on 6/5/2013.

Hart, S. G.; Staveland, L. E. (1988): Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In: Human Mental Workload, vol. 52: Elsevier (Advances in Psychology), pp. 139–183.

Jersild A.T. (1927). Mental set and shift. Archives of Psychology (Whole No. 89, pp.5–82)

Kinnunen M. L., Rusko H., Feldt T., Kinnunen U., Juuti T., Myllyamäki T., Laine K., Hakkarainen P., Louevaara V.: Stress and relaxation based on heart rate variability: Associations with self-reported mental strain and differences between waking hours and sleep. Available online at www.firstbeat.fi, checked on 6/4/2013.

Leinikka, M.; Vihavainen, A.; Lukander, J.; Pakarinen, S. (Eds.) (25th anniversary): Cognitive Flexibility and Programming Performance. Psychology of Programming Annual Conference. Sussex, UK, 25th-27th June 2014. University of Sussex. Available online at http://www.sussex.ac.uk/Users/bend/ppig2014/, checked on 6/27/2014.

Le Fevre, M.; Matheny, J.; Kolt, G. S. (2003): Eustress, distress, and interpretation in occupational stress. In Journal of Managerial Psychology 18 (7), pp. 726–744.

Ochieng, E. G.; Price, A. D. F. (2010): Managing cross-cultural communication in multicultural construction project teams: The case of Kenya and UK. In International Journal of Project Management Volume 28 (Issue 5), pp. 449–460.

Parayitam, S., Desail, K., & Phelps, L. (2007). The Effect of Teacher Communication and Course Content On Student Satisfaction and Effectiveness. Academy of Educational Leadership Journal, 11 (3), 16.

Plass, J. L.; Moreno, R.; Brünken, R. (2010): Cognitive load theory. Cambridge, New York: Cambridge University Press.

Rubio, S.; Diaz, E.; Martin, J.; Puente, J. M. (2004): Evaluation of Subjective Mental Workload: A Comparison of SWAT, NASA-TLX, and Workload Profile Methods. In Applied Psychology 53 (1), pp. 61–86.

Schellhammer, S.; Haines, R.; Klein, S. (Eds.) (2013): Investigating Technostress in situ: Understanding the Day and the Life of a Knowledge Worker Using Heart Rate Variability. 46th Hawaii International Conference on System Science. Hawaii, 2013.

Schooler C, Mulatu MS, Oates G (1999). The continuing effects of substantively complex work on the intellectual functioning of older workers. Psychology and Aging.14:483–506

Söderström M; Ekstedt M; Åkerstedt T et al (2004): Sleep and Sleepiness in Young Individuals with High Burnout Scores. In SLEEP 27 (7), pp. 1369–1377, checked on 7/8/2014.

Spector, A., & Biederman,I.(1976).Mental set and mental shift revisited. American Journal of Psychology, 89, 669-679

Vandierendonck, A.; Liefooghe, B.; Verbruggen, F. (2010): Task switching: Interplay of reconfiguration and interference control. In Psychological Bulletin 136 (4), pp. 601–626.