INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'09
24 - 27 AUGUST 2009, STANFORD UNIVERSITY, STANFORD, CA, USA

STUDENT FACEBOOK CONNECTIONS IN A GLOBAL PROJECT BASED ENGINEERING DESIGN COURSE

Atsushi "Sushi" Suzuki[1] and Larry Leifer[1]
(1) Center for Design Research, Stanford University

ABSTRACT
To understand and investigate how engineering design teams connect virtually, this study maps and analyzes the Facebook connections in a global project based engineering design course, ME310. Seventy students in eighteen teams and five universities in five different countries worked on nine corporate-sponsored projects for the 2008-2009 academic year. The Facebook connections data were collected at the end of the project and the teaching assistants from each school were surveyed and interviewed about how the students and the teams worked, communicated, and participated in course activities. Analyses suggest that different contexts in the course drive the Facebook connections and the connections relate to the social participation in the course.

This paper also discusses the potential implications of Facebook connections tied to existing social science theories and new questions that arose from this study.

Keywords: design education, teamwork, social network, student design teams

INTRODUCTION
New social networking sites such as Friendster, Facebook, MySpace, and Linkedin have created platforms for people to connect, interact, and communicate with one another. Users join these services, upload their profiles and pictures, and establish connections with each other as "friends." With the vast amount of social ties now expressed online, researchers are asking many questions: How are these connections established? What kind of people use Facebook extensively? Does Facebook replace or supplement other more traditional modes of interaction? What do the connections on Facebook indicate?

One study showed that college students used Facebook in conjunction with studying, and decreased their usage over weekends but increased their usage over holidays, indicating that Facebook is used in support of geographically distant relationships [6]. Another study showed that users typically use Facebook to find out more about people they meet online rather than using the site to initiate new connections [8].

This study investigates how students in a global project based engineering design course, ME310 are connected to each other through Facebook. The goal of this study is three fold: a) To map and better understand how students are connected in ME310; b) explore the implications of such connections; c) to tie existing theories in the social sciences such as weak ties, social capital, and social networks to Facebook connections and usage.

Facebook
Facebook is the world's largest social networking site with more than 200 million active users (as of June 2009). Started in February 2004, the site was originally limited to Harvard students but later expanded to other universities. In September 2006, it became available to the general public. According to Alexa Internet, Facebook is the world's fourth most trafficked website behind Google, Yahoo!, and YouTube (as of June 2009) [2].

Facebook users can create profiles and share information such as age, gender, contact information, and education and work background. Additionally, a user can establish a bidirectional connection with another user by adding them to their friend list. A connection is established when one user initiates a

friend request and the recipient user accepts the request. Once the connection is made, users are able to interact in different ways such as writing on each other's "walls" (message boards visible by a limited group of users), sharing photos, inviting each other to events, etc.

ME310

ME310 is a yearlong project-based engineering design course where student teams from Stanford University and partner universities collaborate on real world design problems brought forth by corporate partners. For every project, two teams of three to five students, one from Stanford University and one from a partner university, work together for the academic year, and .o two projects are identical. Students are required to produce one final prototype and documentation amongst the two teams. For the 2008-2009 academic year, nine projects and eighteen teams were formed from seventy students at five different universities. Nine teams were based at Stanford University, from here on referred to as School A, while School B hosted three teams and School C, D, and E hosted two teams each. Figure 1 shows the organization diagram for ME310 2008-2009.

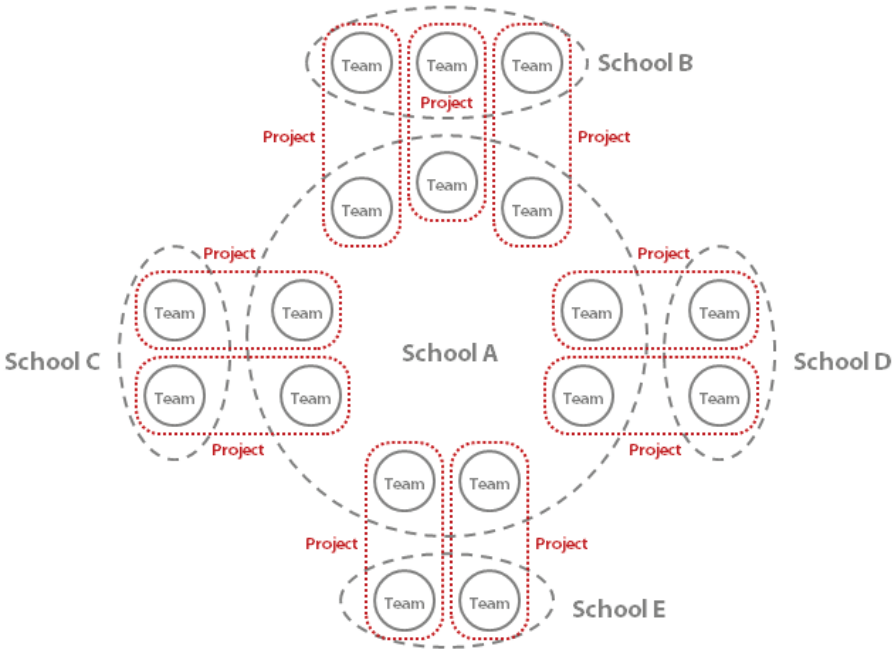

Figure 1. ME310 organization diagram for the 2008-2009 academic year

METHODOLOGY

The student connection data (who is Facebook friends with whom) was collected at three distinct times on February 22nd 2009, May 23rd 2009, and June 6th 2009. The course began in September 2008 while the corporate projects began on October 23rd 2009. The final presentations for the course were held on June 4th 2009, two days before the final data was collected and one week before the course officially concluded. Unless otherwise noted, the data discussed in this study is from June 6th, the newest dataset collected.

Connections amongst the students were manually captured from their profiles. Since some students added the author as a friend, other students were added by the author as friends, and many students shared the same network as the author, all the student connections were visible (but not all the profiles). No other interactions, such as wall posts or comments on pictures, were captured.

DATA

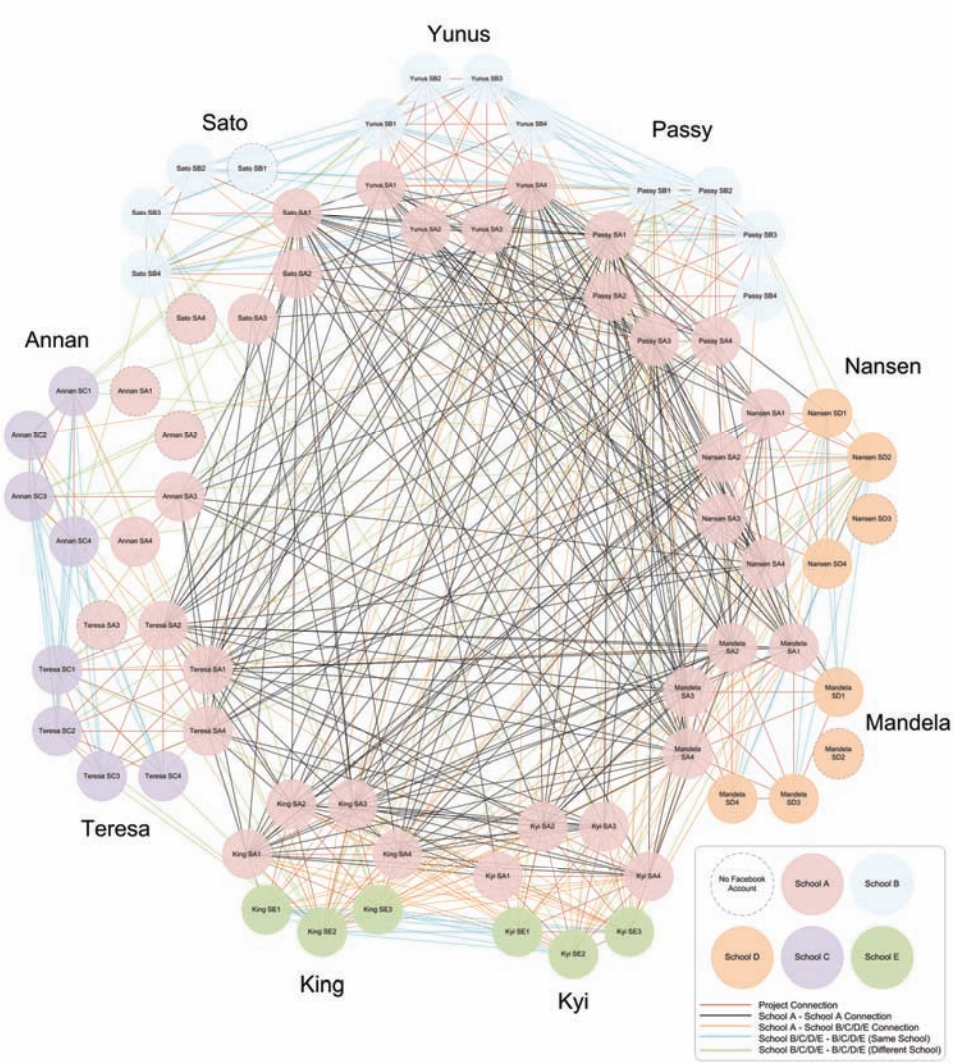

Figure 2. Facebook Connections between students in ME310

Figure 2 shows the Facebook connections amongst all students in ME310 for the 2008-2009 academic year. Student teams are organized in clusters around their projects, which are presented by pseudonyms for companies sponsoring the projects. School affiliations are expressed by the colors of the circles, and a dashed border around the circle indicates a student whose Facebook account could not be found (most likely not owning one). The line colors indicate the type of connection that is represented: red lines are connections within the same project which takes precedence over all other line colors; for the students at School A, black lines are connections between the same school and orange lines are connections between students at different schools; for the students at School B, C, D, or E, blue lines are connections between students at the same school and green lines are connections between students at different schools (but not School A).

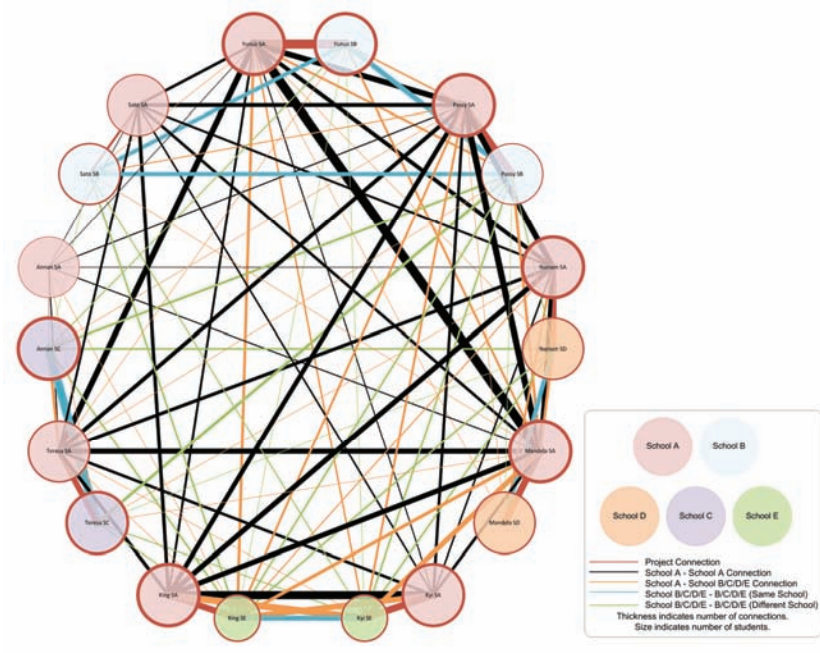

Figure 3. Facebook connections between teams in ME310

Figure 3 shows the Facebook connections amongst all the teams in ME310. Thickness of the lines indicate the number of connections between the teams. Size of the circle indicates the number of students in the team.

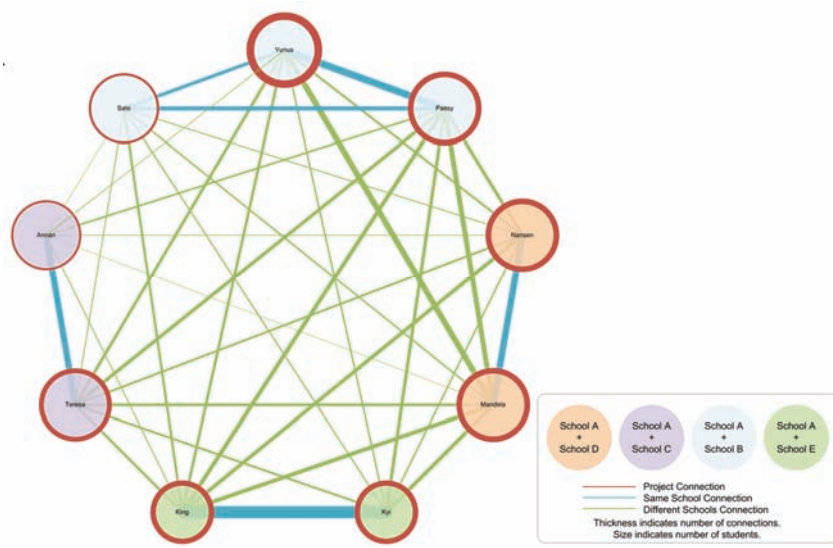

Figure 4. Facebook connections between projects in ME310

Figure 4 shows the Facebook connections amongst all the projects in ME310. Thickness of the lines indicate the number of connections between the projects. Size of the circle indicates the number of students in the project.

CONTEXT AND CONNECTIONS

In the following sections, the number of connections will be analyzed against different contexts within the course such as working on the same team, team location in the course design loft, etc.

Type of Connection

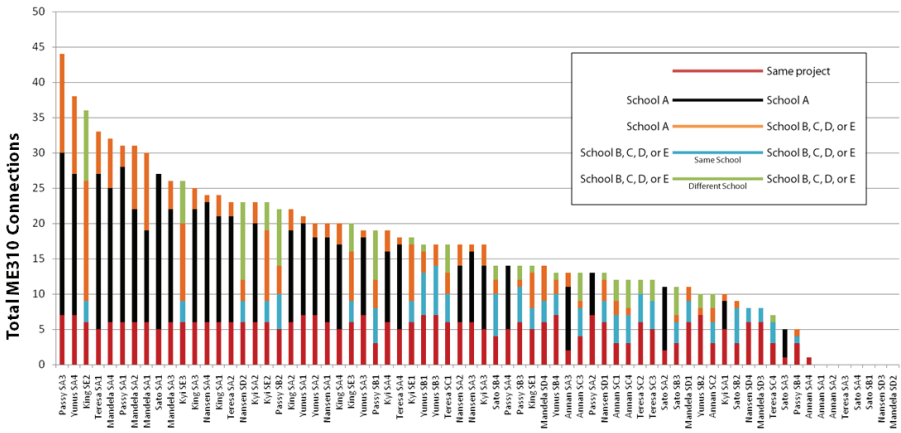

Figure 5. Number of connections in ME310 for each student

Figure 5 shows the number of connections in ME310 for each student. Since there were 70 students, the maximum number of connections one student can have is 69. The colors show the type of connection each student established.

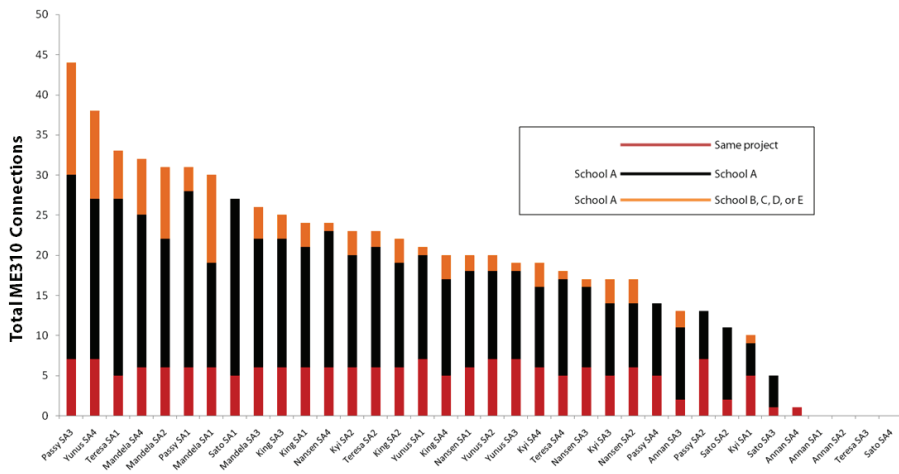

Figure 6. Number of connections in ME310 for each student at School A

Figure 6 shows only the students at School A. From this, one can see that most students on the left (more connections) had about the same number of connections within the project (red). The increasing amount of black and orange to the left show that the differences in number of connections were mostly due to the number of connections outside of the projects.

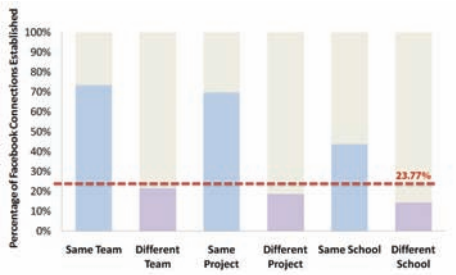

Figure 7. Percentage of connections established by connection type

Figure 7 shows the percentage of connections established within each connection type. This shows that more connections were established between students in the same team than in different teams, students in the same project than in different projects, and students in the same school than in different schools. While it is not surprising that students who work more closely together are better connected, it is interesting to note that those trends become visible on Facebook. Note that for the entirety of ME310, 574 out of 2415 possible connections were established for a link density of 23.7%.

Loft Location (School A only)

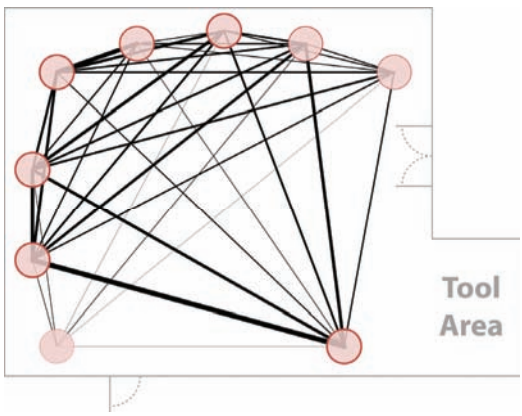

Figure 8. Team connections at School A arranged by respective design loft placement

Students at School A had 24/7 access to the ME310 design loft, where each team was given space to work on their projects. Figure 8 shows the respective loft placement of the teams and the Facebook connections between the teams. Note that the thickness of the lines indicate the number of connections established between members of the teams. As can be seen, the two teams at the bottom left and top right corners had much less Facebook connections with the rest of the class than other teams in the loft.

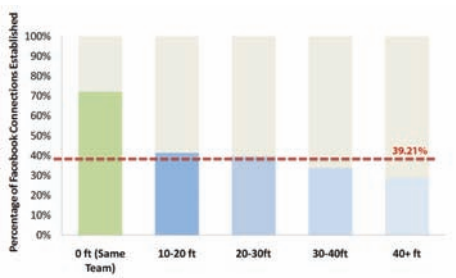

Figure 9. Percentage of connections established by team loft placement distance

Figure 9 shows the percentage of connections established between the teams placed at a certain distance in the loft. The percentage of connections established dropped as teams were placed further away from each other. At school A, 247 out of 630 possible connections were established for a link density of 39.21%.

Design Review Schedule (School A only)

During the winter and spring quarters, teams at School A had weekly design review meetings with the instructors and/or teaching assistants on either Tuesday or Thursday. Student teams selected the schedules for the meetings to best fit their other academic and personal commitments. Since major course deadlines were due in these weekly meetings, some teams spent considerable amount of time in the loft on Monday and others on Wednesdays.

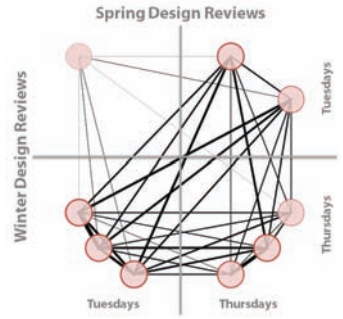

Figure 10. Team connections at School A arranged by design review schedule

Figure 10 shows the teams at School A who had design reviews on Tuesdays and/or Thursdays in the winter and spring quarters. Teams in the same quadrant had the same design review schedule for both quarters, teams in adjacent quadrants had the same design review schedule for one quarter, and teams in opposite quadrants did not share design review schedules for both quarters.

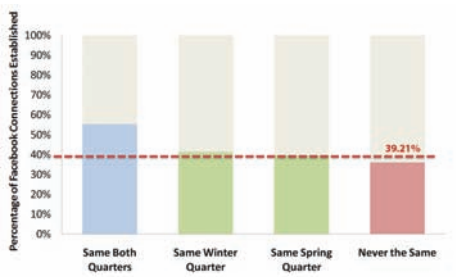

Figure 11. Percentage of connections established by design review schedule

Figure 11 shows the percentage of connections established for students who had the same design review schedule for both quarters, winter quarter only, spring quarter only, and neither quarters. As can be seen, students who had the same design review schedule both quarters had more possible connections established than those who did not.

Paper Bike Teams

Paper Bike is a two-week warm up design exercise in ME310 before the corporate projects begin. Student teams are tasked with creating a fully functional vehicle mostly out of paper to partake in a game that varies from year to year. The purpose of this exercise is to provide the students with a short design exercise that mirrors the corporate project in a topic that no student is an expert in. It has been shown that repeated cycles of experience improve the understanding between theory and practice [10]. There is no collaboration between teams at different schools for Paper Bike, and teams were formed by the teaching assistants and, which were different from the corporate projects.

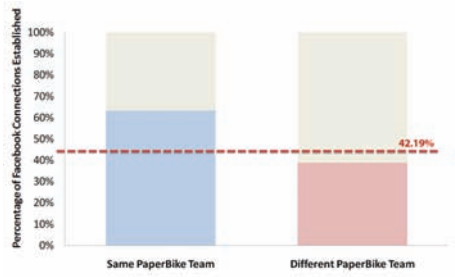

Figure 12. Percentage of connections established in Paper Bike Teams

Figure 12 shows the percentage of connections established between members of Paper Bike teams. Note that the connection data was collected on June 6th 2009, eight months after the Paper Bike exercise was over. Students who were on the same Paper Bike teams still had a higher percentage of Facebook connections established amongst each other than with students outside of their teams.

Summary

The above analyses show that the percentage of possible Facebook connections established is related to the context in which the students are placed. Students in the same team, project, and school established more connections than students in different teams, projects, and schools. Students placed closer to each other in the design loft established more connections than those placed further away. Students who had similar deadline schedules and henceforth similar loft working hours established more connections than those who had dissimilar schedules. The question of causality is valid for these cases. For the corporate projects, some teams were self-formed leaving the possibility that students who were friends (and connected in Facebook) decided to be on the same team. However, none of the students from different schools knew each other before the projects started, and the two teams that worked on the same projects were picked by the instructors, not the students. Paper Bike teams were also determined by the instructors and teaching assistants, as were team loft locations at School A. Student teams did sign up for SGM timeslots, but it's unlikely that student teams considered other teams while deciding.

CONNECTIONS AND SOCIAL PARTICIPATION

Once the entire ME310 Facebook network was uncovered and mapped, this study sought out to find out if these connection patterns indicated any patterns in the physical domain.

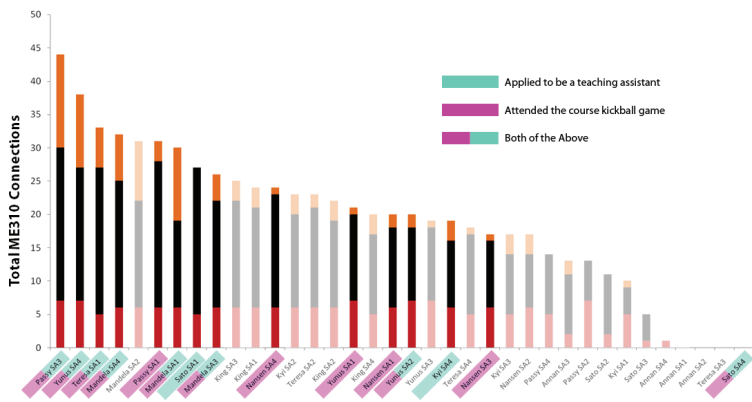

Figure 13. Students at School A who applied to be teaching assistants and/or attended the course kickball game and their total ME310 Facebook connections

Figure 13 shows the number of connections each student at school A established in ME310 and which students appeared at the course kickball game and/or applied to be teaching assistants for the

following academic year. As one can see, both the students who appeared at the kickball game and students who applied to be teaching assistants on average had more Facebook connections in ME310 than those that did not. The data seems to indicate that students with more connections in the course were more active in the course than those with fewer connections.

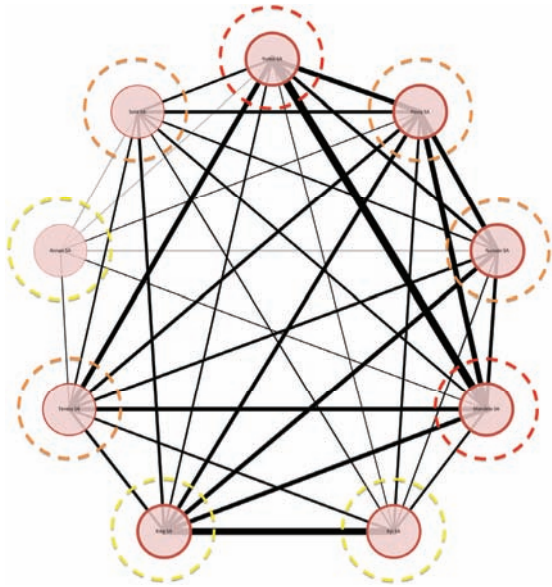

Figure 14. Facebook connections between teams at School A and level of social participation in course

Near the end of the course, the teaching assistants at each school were interviewed about the teams' working style, social connectivity, and design process. Figure 14 shows the connections between the student teams at School A. Note that the thickness of the lines indicates the number of connections established between the students in each team. According to the teaching assistants at School A, the two teams indicated by the red dashed lines were the most socially active in the course, spending the most amount of time in the loft and attending many of the course events. The four teams in orange had some team members who actively participated in course events while others were not as active. The three teams in yellow were least visible at course events and generally considered to be the least active of the teams. The graph shows that teams who were more active in the course had more connections amongst themselves than those who were less active in the course.

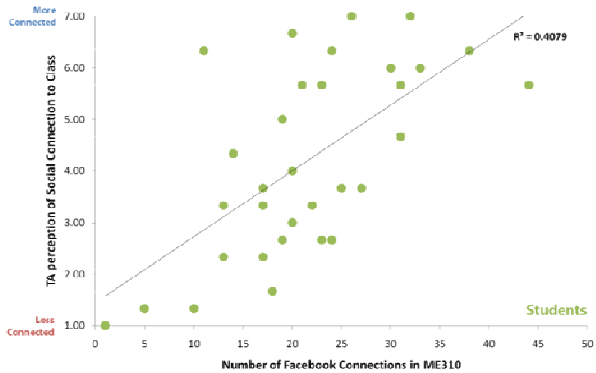

Figure 15. TA perception of social connectedness to class for students

In addition to providing observational data, the teaching assistants at School A rated each student and team on how socially connected he/she/they were to the class on a seven point scale with 7 as most connected and 1 as least connected. Figure 15 shows the social connectedness rating plotted against the number of Facebook connections each student at School A had in ME310.

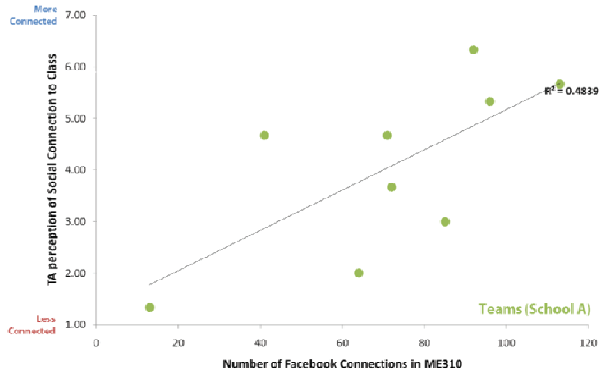

Figure 16. TA perception of social connectedness to class for teams at School A

Figure 16 shows the social connectedness rating plotted against the total number of Facebook connections each team at School A had in ME310. The above two figures hint that there is a relationship between teaching assistant perception of student and team social participation in the course and the number of Facebook connections established within the course.

DISCUSSION

Just because two students are connected in Facebook does not mean they are communicating through Facebook or through any other medium. Research has shown that "users tend to interact mostly with a small subset of friends, often having no interaction with up to 50% of their Facebook friends." [11] However, that does not mean these connections are worthless. There have been many studies done on the "Strength of Weak Ties," where social scientists focused on the transfer of information through casual acquaintances (weak ties) rather than friends and family (strong ties). Some studies have shown that "the use of weak ties in finding jobs has a strong association with higher occupational achievement" and "weak ties provide the bridges over which innovations cross the boundaries of social groups"[7]. With social network services such as Facebook and Linkedin, people are now identifying and expressing their weak ties online.

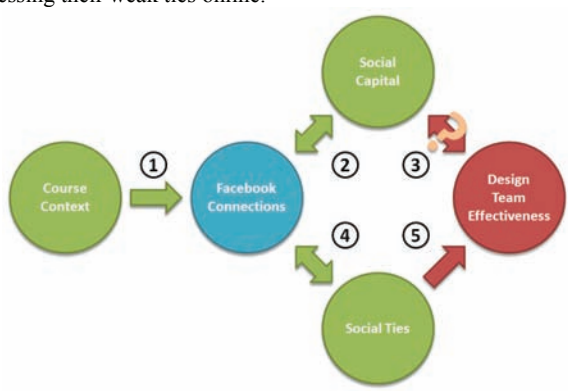

Figure 17. Links between different elements in various theories

Through the initial exploration, this study shown that contexts in the course drive Facebook connections, which is shown as link (1) in Figure 17. A study has shown that students with more

Facebook connection and usage exhibit higher social capital which is shown as link (2) [5]. According to Bourdieu and Wacquant, "[Social capital is] the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" [4]. If financial capital is the value people own in money and human capital is the value people accrue through education and experiences, social capital is the value people gain through the connections they establish. "Social capital has been linked to a variety of positive social outcomes, such as better public health, lower crime rates, and more efficient financial markets" [1]. Social capital has not been linked to better team effectiveness, shown as link (3), but since "engineers fundamentally deal with ambiguous requirements and problems," social capital and trust in people are essential to successful decision making [9].

In the second part of the exploration, this study has shown that Facebook connections in ME310 relate to the social participation in the course or the social ties of students within the course, shown as link (4) in Figure 17. It should be no surprise that the virtual social connections also relate to the physical social connections. Over the last fifty years, many studies in the field of social network analysis have looked at network structure and design team effectiveness, defined by both task performance and team viability (team's ability to retain members). A meta-analysis of thirty-seven studies showed that density of team's network of ties correlate with team performance and viability, team level-centrality in inter-team networks benefits team task performance, and having a more integrative network structure is beneficial for future team task performance [3]. The last point is especially pertinent as it establishes the causal order: social network structure determines team effectiveness.

Given the above body of work, this study highlights two implications. First, designing the course context can positively or negatively affect team effectiveness. While this should not sound shocking, in the field of design, more emphasis tends to be placed on process and team composition rather than on context. Second, Facebook connections, by virtue of measuring one's weak (and strong) ties and expressing his/her social network, could be used as a real-time measure of one's social capital and connectedness within an organization. If companies could measure some vital social network parameters of their entire and portions of their organization on Facebook, they could redesign the working context to achieve better social connectedness.

NEXT QUESTIONS

This study is only the first step in trying to understand how Facebook connections are established in design teams and organizations and the larger implications of such explicit displays of social ties. There are still many questions surrounding the issue on both sides of Figure 17. On the left side: What kinds of context drive Facebook connections and to what degree? Are there certain events or triggers that cause connections to be established? How can one design a course, company, or organization to maximize the social connectedness? On the right side: Does higher social capital lead to better team effectiveness? Can Facebook connections replace traditional surveys in capturing social network data for the purposes of running analysis? Does denser and more central Facebook connectivity within an organization lead to better team effectiveness?

The internet has fundamentally altered the way we communicate, work, and consume information. Social network services have changed the way we stay in touch with people and have created a new way of interacting with one another. People are now expressing their social ties online, information that once lived in phone books and rolodexes. Does this information have any value, and if so, can we use it?

REFERENCES

[1] Adler, Paul S, and Seok-Woo Kwon. "Social Capital: Prospects for a New Concept." The Academy of Management Review, 2002: 17-40.

[2] Alexa Internet. Alexa Top 500 Global Sites. http://www.alexa.com/topsites (accessed June 18, 2009).

[3] Balkundi, Prasad, and David A Harrison. "Ties, Leaders, and Time in Teams: Strong Inference about Network Structure's effects on Team Viability and Performance." Academy of Management Journal, 2006: 46-68.

[4] Bourdieu, Pierre, and Loïc J D Wacquant. An invitation to reflexive sociology. Chicago: Published by University of Chicago Press, 1992.
[5] Ellison, Nicole B, Charles Steinfield, and Cliff Lampe. "The Benefits of Facebook "Friends:" Social Capital and College Students' Use of Online Social Network Sites." Journal of Computer-Mediated Communication, 2007: 1143-1168.
[6] Golder, Scott, Dennis Wilkinson, and Bernardo Huberman. "Rhythms of social interaction: Messaging within a massive online network." Communities and Technologies 2007. East Lansing: Springer, 2007. 41-66.
[7] Granovetter, Mark. "The Strength of Weak Ties: A Network Theory Revisited." Sociological Theory (American Sociological Association), 1983: 201-233.
[8] Lampe, Cliff, Nicole Ellison, and Charles Steinfeld. "A Face(book) in the Crowd: Social Searching vs. Social Browsing." CSCW'06. Banff: ACM, 2006. 167-170.
[9] Larsson, Andreas. "Banking on social capital: towards social connectedness in distributed engineering teams." Design Studies, 2007: 605-622.
[10] Leifer, Larry. "Design Team Performance: Metrics and the Impact of Technology." In Evaluating Corporate Training, by Stephen Michael Brown and Constance J. Brown, 297-319. Springer, 1997.
[11] Wilson, Christo, Bryce Boe, Alessandra Sala, Krishna P. N. Puttaswamy, and Ben Y. Zhao. "User Interactions in Social Networks and their Implications." EuroSys '09. Nuremberg: ACM, 2009.

Contact: Atsushi “Sushi” Suzuki
Center for Design Research, Stanford University
Department of Mechanical Engineering
Tel: +1 (832) 567 1880
E-mail: sushis@stanford.edu

Sushi Suzuki is a Ph.D. candidate at the Center for Design Research and the program developer for ME310 where he was previously a student and a Teaching Assistant. As a practitioner of the Stanford-IDEO design methods, he has worked on various design challenges ranging from video game controllers to developing world education tools and new radio segments for NPR. Sushi is interested in researching how to design better design environments for teams and organizations.

Larry is a Professor in Mechanical Engineering at Stanford University and the Director of the Center for Design Research (School of Engineering). His design thinking and informatics research is concerned with understanding, supporting and improving design practice, including issues in research methodology, team dynamics (co-located and distributed), innovation leadership, interactive design spaces, collaboration technology, and design-for-wellbeing.