

# Detecting Professional versus Personal Closeness Using an Enterprise Social Network Site

Anna Wu

Pennsylvania State University  
327 IST Building, University Park, PA, 16803  
annawu@psu.edu

Joan M. DiMicco, David R. Millen

IBM Research  
One Rogers St, Cambridge, MA 02142  
{joan.dimicco; david\_r\_millen}@us.ibm.com

## ABSTRACT

In this work we analyze the behavior on a company-internal social network site to determine which interaction patterns signal closeness between colleagues. Regression analysis suggests that employee behavior on social network sites (SNSs) reveals information about both professional and personal closeness. While some factors are predictive of general closeness (e.g. content recommendations), other factors signal that employees feel personal closeness towards their colleagues, but not professional closeness (e.g. mutual profile commenting). This analysis contributes to our understanding of how SNS behavior reflects relationship multiplexity: the multiple facets of our relationships with SNS connections.

## Author Keywords

Workplace relationships, social media, multiplexity, tie strength, social network sites, organizations.

## ACM Classification Keywords

H5.3. Group and Organization Interfaces: Computer-supported cooperative work; Web-based interaction.

## General Terms

Human Factors

## INTRODUCTION

Online social network sites (SNSs) have become established mechanisms for maintaining connections to both strong and weak relationship ties [10]. Behind the firewall, companies, including Best Buy, Deloitte, Microsoft, and IBM, are starting to host their own internal social network sites for the purpose of enabling communication and collaboration across organizational boundaries [4]. Organizations hosting internal social network sites can benefit from knowing more about the relationships between employees: this knowledge can inform strategic team formation, human resource decisions, and resource allocation [5]. Social network research has found that weak ties assist people in finding jobs [14] and

enable the spread of information between an organizational divisions [16]. Strong ties in a network are beneficial for support during times of crises and for obtaining timely informational support [5].

While a company's organizational chart can provide information about professional closeness and the formal structure of the enterprise, it cannot fully reflect the complexities of the social networks inside the workplace [5]. For example, the company directory does not show who an employee trusts, cares about, and chooses to spend time with outside the workplace. Relationships that transcend current projects and team structures can be the strongest and most meaningful, yet they are not represented within official company databases.

This is where analysis of social software usage may help. Recent work by Gilbert and Karahalios presented a model for predicting relationship strength based on behavior on Facebook, today's most popular and ubiquitous social network site [12]. Their findings indicate that different behaviors on Facebook reveal the strength of relationships between friends. However, we know that people socialize differently in the workplace than in their personal life because of the professional context. It may be that interactions on a company's internal tool are not indicative of relationship closeness because these tools are used for different purposes than external social network sites, which are used primarily for keeping in touch with friends [3].

In this work we present an analysis of the behavior of employees on a company-internal social network site to determine if relationship closeness can be predicted from employees' SNS interactions. We compare users' perceptions of their relationships with coworkers to their interactions with these coworkers on a company's internal SNS. Given the nature of workplace relationships, that span professional and personal dimensions, these two facets of workplace relationships are the focus of our analysis. We find that certain SNS behaviors signal professional closeness and others signal personal closeness and a core concept relating to these findings is "relationship multiplexity."

## RELATIONSHIP MULTIPLEXITY

Relationship multiplexity refers to the multiple facets in social relationships. As defined by Barnes [1], multiplexity is a network tie characteristic that reflects whether a social

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relationship serves more than one purpose or entails more than one type of social activity. A multiplex relationship within the workplace is one where coworkers share more than one dimension of interests ([1] pp.412). And when two persons have a multiplex relationship, each dimension impacts the other. For example, a conflict between two persons in the workplace can cause problems for their friendship, or vice versa. To this extent relationships cannot be simply categorized as purely professional or personal.

To maintain multiplex relationships with coworkers, employees alter their behavior for different communication contexts and media. For example, within a meeting, people speak and behave rationally as a course of doing business, but after the meeting over lunch may share more personal perspectives and emotional responses to the events of the workplace. This balancing of behavioral norms and appropriateness can be understood through Goffman's distinction between 'front stage' and 'back stage' performances [13]. Within the workplace, people are continually balancing, and sometimes struggling with, their self-presentation, as they juggle the social norms of different workplace contexts.

A social network site inside the enterprise is a unique platform that allows us to study this tension. People have a professional identity in the workplace, but a social network site is for socializing: which side of a coworker relationship is reflected in the behavior on the site? This tension of multiple presentations of self online has been discussed elsewhere [2, 6], but here we attempt to determine how relationship facets are reflected through explicit behavior on an SNS in the workplace setting.

The concept of multiplexity has been examined previously in terms of social networks and technology, but the focus has been on "media multiplexity:" the concept of using different media for maintaining types of relationships. For example, individuals may favor using the phone for communicating with friends and email for communicating with coworkers. The research in this area has found that, in general, the more frequent the communication with the connection, the greater the number of communication tools used to communicate [16, 17, 18], provided certain conditions are met, such as uniform availability of tools [19].

To understand the issue of relationship multiplexity and SNS use in the workplace, we are focusing our analysis on two dimensions of relationships between colleagues: *professional vs. personal* closeness. As a conceptual framework, Table 1 illustrates how professional and personal closeness vary along the spectrum of strong and weak ties. Strong professional ties work closely together and frequently exchange information relating to work tasks and critical job-related information. Strong personal ties also communicate regularly, but may not work together, and the primary basis of their communication is for emotional, or non-task oriented, support. While our

framework is treating these as separate concepts, these two types of strong ties coexist within a multiplex relationship.

	Strong tie	Weak tie
Professional Closeness	Work in the same group or on same project; Exchange frequent information about work tasks.	Communities of practice, professional organizations; Exchange work tips.
Personal Closeness	Long relationship history, communicate regularly; Exchange news of major and minor life events.	Lost touch colleagues, people you work near, but not with; Exchange casual banter.

**Table 1. Conceptual framework along the dimensions of personal/professional closeness and strong/weak ties**

### Research Questions

Based on this framework, this paper answers two research questions. The first is:

*How does behavior on a company-internal social network site reflect the relationships between a company's employees?*

By answering this initial question, this work contributes to the broader research on measuring the strength of ties in social media by adding a new context, the workplace, to the existing findings on external sites.

Based on the issues of relationship multiplexity in the workplace, our second question is:

*What are the strongest behavioral predictors of professional versus personal closeness in the workplace?*

By answering this question, we will be providing a mechanism for detecting these two facets of workplace relationships. And in understanding how professional and personal closeness predicts weak and strong ties, we expect to determine the important behavioral factors that describe the four combinations in Table 1.

The following section discusses enterprise social network sites and related work in this area of understanding how employees use these sites.

### ENTERPRISE SOCIAL NETWORK SITES

A growing number of companies are launching internal deployments of social network sites to encourage employees to share both professional and personal information with each other on the corporate intranet [4]. These sites are frequently built with commercial tools and customized for the company, and they often share a core set of features that can also be found on external SNSs:

- Employees can create online profiles that can be customized with a wide range of content, typically including about-you's [9].
- Users can articulate their relationships with other coworkers by connecting to them on the site. Once a connection link is established, users can track the

activities of colleagues, much like Facebook's news feeds.

- The primary activity on the internal SNS is content sharing, which can include status message updates, photo sharing [27], lists sharing [11], and blogs [20].
- Many of the sites support commenting so that conversations between employees can occur across the site, and serve as a mechanism for informal communication between employees.

Additionally, an SNS behind the firewall typically directly connects each profile to information in the company's employee directory and users typically log in to the SNS with their corporate identification. Different facets of relationships cannot be selectively expressed on different tools in the enterprise because the tools are linked to one another and this tension between professional identity and non-professional identity is brought together. This lack of anonymity, or rather this persistent identity throughout the corporate intranet, is one of the reasons why we hypothesize that the communication on a corporate SNS particularly reflects the multiple aspects of relationships with colleagues, not simply the personal side which is reflected on an external site such as Facebook. On an SNS, where the social norm is to share on a more personal level, multiple tensions can arise in terms of what information to share with whom [26].

#### The SNS Beehive

This paper focuses on the SNS Beehive that was deployed at IBM in 2007. Since launching, 60,000 employees joined the site (~15% of the company) and between 6000 and 13,000 employees are currently visiting the site each month. Over 400,000 network connections have been made between employees and 150,000 comments have been left on thousands of profiles, photos and lists.

Beehive has many features common on Internet SNSs such as articulated social networks, profile pages, photo sharing, status updates, and commenting on profiles and content. Because of this, behavior on Beehive can be generalized to behavior on any SNS.

As mentioned in the previous section, company intranet authentication credentials are used for logging into the site, so browsing and connecting is never anonymous. Another key difference between Beehive and Internet SNSs is users can view each other's content without being connected: any user can see any other user's profile and all of their publicly shared photos and lists without being a "connection" of the user. Users can also leave comments on any of the profiles and content on the site. A specific, unique feature of Beehive, which will turn out later to be of significance, is content recommendations. A user can recommend a photo, for example, to another user as something they might find interesting. And unlike common Internet SNSs, there is no private messaging on Beehive. These differences limit the generalizability of an analysis of behavior on the site.

Why do IBM employees use Beehive? In terms of content, users share a wide range of information on the site, from describing hobbies and personal life events to discussing project ideas and brainstorming around corporate-driven topics. The personal and professional content co-exist and is encouraged to, by the design of the site [19].

Previous research on the site's active users found that they were using the site for "social browsing" [20]: discovering and connecting with colleagues that they did not know well at all [7]. This indicates, along with the previous work describing the mixture of professional and personal content, that Beehive is used for communicating with weak ties of both a professional and personal nature. Employees additionally report being motivated to use the site to promote their careers and the projects within the company, both professional pursuits.

This site is an environment in which employees interact and communicate with each other in different ways, and all of this communication likely signals the type and strength of their relationships. Yet other sites, such as Facebook and LinkedIn, likely have similar data about coworker connectedness. For example, Skeels and Grudin studied the use of Facebook and LinkedIn at Microsoft and identified three primary uses: reconnecting with distant colleagues and friends, maintaining and sharing CV information, and building social capital [26].

Furthermore, SNSs are not the only social software which reflects relationship strength about coworkers. To support social network analysis, as well as to develop applications for enterprise tasks such as expert finding, social network information has been extracted from enterprise applications such as email [23], and document repositories such as patenting and co-authorship databases [21], and combinations of multiple internal enterprise sources [15]. In these example works, relationship strength is calculated by the number of ties or connections between individuals and via other indications of communication, yet this research has not included verifying which behaviors are indicative of relationship strength.

#### METHOD

To determine if coworker relationship strength is revealed through interaction on an internal SNS, we asked the company's SNS users to subjectively rate the closeness of their relationships with people they had interacted with on the site over the previous year. Then we analyzed different aspects of their online interaction, along with company directory information, by using a regression model to determine if these factors could accurately predict the subjective judgments of relationship closeness. The questions in the subjective rating task asked about professional and personal closeness, enabling our analysis to separate out these two different concepts.

#### Data Collection

196 active Beehive users were invited to complete the relationship-rating task, based on their consistent and high

level of contribution and viewing activity on the site over the past year. For the task, subjects were asked to map up to 50 of their colleagues that they had interacted with on Beehive. (If the subject had interacted with less than 50, they were asked to map all of them.) These ‘friends’ that the subject rated were either employees the subject had listed as connections on their profile page, or employees whom they had commented on at least 3 times or had viewed at least 10 times during the last year. To address the issue that subjects may not remember viewing 10 pages of a particular employee’s content, subjects were allowed to mark any of these people as “strangers” and this would remove them from the mapping task.

The mapping task asked three questions regarding general closeness, professional closeness and personal closeness:

*Q1: “How strong is your relationship with each of these people?”*

*Q2: “How closely are you currently working with each of these people?”*

*Q3: “How likely are you to talk about your non-work life with each of these people?”*

To answer each question on a range of “not at all” to “very,” subjects dragged their friends from a list onto a circular canvas, where the closer the friend’s picture was placed to the subject’s picture in the center, the closer the subject indicated the relationship was. Figure 1 shows a screenshot of the tool. The pixel distance from the center of the user to each friend then was used as a continuous measurement of closeness.

We asked users to map their friends in one single step for each question to avoid possible task fatigue (as reported by [12]). By using a circular target, all friends could be mapped without occluding each other and could be rated in relation to one another, a method also used by [25]. The angular position was not used for this analysis, but because users may have interpreted the angular position as meaningful, this is a potential weakness of our data collection method.

**Dependent variables**

The subjects’ responses to the prior three questions were treated as the dependent variables in the analysis. After collecting and cleaning the data<sup>1</sup>, 93 subjects’ ratings produced 4009 subject-friend pairs available for analysis.

Using pixel distance, relationship strength was transformed to a scale between 0 (very close) to 1 (not at all close). Any friends placed outside the circle were rounded to a radius of 1. The friends marked as strangers prior to the mapping tasks were coded as 1.1.

The first question, addressing general closeness, correlated strongly with both the professional question and the personal question (general vs. professional:  $r=0.622$ ,  $p<0.01$ ; general vs. personal:  $r=0.631$ ,  $p<0.01$ ), while the responses to the professional and personal closeness questions had a lower correlation to each other ( $r=0.478$ ,  $p<0.01$ ). Higher absolute value of the r-value indicates stronger correlation and the p-value indicates the significance of the existence of such correlation. The means, standard deviations and distributions for the three questions are shown in Table 2. This close correlation of the general question with the other two is a good indication that this question is in fact general, while the other two questions address more specific aspects of the relationship.



Figure 1. Screenshot of tool used for collecting subjective ratings of relationship closeness

Questions	Mean	SD	Distribution (very close to not at all close)
<b>General closeness</b> <i>How strong is your relationship?</i>	0.64	0.32	
<b>Professional closeness</b> <i>How closely are you currently working?</i>	0.74	0.31	
<b>Personal closeness</b> <i>How likely are you to talk about your non-work life?</i>	0.70	0.33	

Table 2. Distributions of subjects’ subjective ratings

<sup>1</sup> The cleaning process removed data of those subjects who did not complete all the questions. We also removed three subjects’ data as outliers due to their atypical behavior on the SNS.

Subject's Behavioral Factors	Variables Contributing to Each Factor
General Activity (0.847)	<ul style="list-style-type: none"> <li>Num content page views</li> <li>Num site logins</li> <li>Num photo comments written</li> <li>Num list comments written</li> <li>Num list created</li> </ul>
Connecting (0.718)	<ul style="list-style-type: none"> <li>Num connections</li> <li>Num profile comments written</li> </ul>
Content Creation (0.811)	<ul style="list-style-type: none"> <li>Num photos shared</li> <li>Num status message updates</li> <li>Num about-you's written on profile</li> </ul>
Friend's Behavioral Factors	Variables Contributing to Each Factor
General Activity (0.859)	<ul style="list-style-type: none"> <li>Num content page views</li> <li>Num site logins</li> <li>Num photo comments written</li> <li>Num list comments written</li> <li>Num list created</li> </ul>
Connecting (0.687)	<ul style="list-style-type: none"> <li>Num connections</li> <li>Num profile comments written</li> </ul>
Content Creation (0.544)	<ul style="list-style-type: none"> <li>Num photos shared</li> <li>Num status message updates</li> <li>Num about-you's written on profile</li> </ul>
Subject-Friend Interaction Factors	Variables Contributing to Each Factor
Explicit friendship (NA)	<ul style="list-style-type: none"> <li>Subject lists friend as a connection</li> </ul>
Subject viewing friend (0.975)	<ul style="list-style-type: none"> <li>Friend views on all types of subject content (profile + photos + lists)</li> <li>Subject views on friend's profile</li> <li>Subject views on friend's photos</li> <li>Num photo comments subject left friend</li> </ul>
Friend viewing subject (0.917)	<ul style="list-style-type: none"> <li>Friend views on all types of subject content (profile + photos + lists)</li> <li>Friend views on subject's profile</li> <li>Friend views on subject's photos</li> <li>Num photo comments friend left subject</li> </ul>
Subject interacting with friend's lists (0.829)	<ul style="list-style-type: none"> <li>Subject views on friend's lists</li> <li>Subject comments on friend's lists</li> <li>Num common lists that both subject and friend commented on</li> </ul>
Friend interacting with subject's lists (0.989)	<ul style="list-style-type: none"> <li>Friend viewing subject's lists</li> <li>Friend commenting on subject's lists</li> <li>Friend having lists with same title as subject's lists</li> </ul>
Recency and length of friend visiting subject's content (0.622)	<ul style="list-style-type: none"> <li>Days since first time friend visited subject's profile content</li> <li>Days since last time friend visited subject's profile content</li> </ul>
Recency and length of subject visiting friend's content (0.887)	<ul style="list-style-type: none"> <li>Days since first time subject visit friend's profile content</li> <li>Days since last time subject visit friend's profile content</li> </ul>
Mutual profile commenting (0.527)	<ul style="list-style-type: none"> <li>Num profile comments left by the subject for the friend</li> <li>Num profile comments left by the friend for the subject</li> </ul>
Mutual photo commenting (0.667)	<ul style="list-style-type: none"> <li>Num photos that subject and friend both commented on</li> <li>Num comments subject made on friend's photos</li> <li>Num comments friend made on subject's photos</li> </ul>
Profile similarity (NA)	<ul style="list-style-type: none"> <li>Num common about-you questions on friend's and subject's profiles</li> </ul>

Content Recommendations (0.365)	<ul style="list-style-type: none"> <li>Friend's content recommendations to subject</li> <li>Subject's content recommendations to friend</li> </ul>
Mutual Connections Factors	Variables Contributing to Each Factor
Mutual connections factor (0.949)	<ul style="list-style-type: none"> <li>Num mutual connections between the subject and the friend</li> <li>Total views the subject and the friend made on their mutual connections' content</li> <li>Total views the subject and the friend made on their mutual connections' profiles</li> <li>Total views the subject and the friend made on their mutual connections' photos</li> <li>Total views the subject and the friend made on their mutual connections' lists</li> <li>Total views all mutual connections made on the subject's and the friend's content</li> <li>Total views all mutual connections made on the subject's and the friend's profiles</li> <li>Total views all mutual connections made on the subject's and the friend's photos</li> <li>Total views all mutual connections made on the subject's and friend's lists</li> </ul>

**Table 3. SNS Behavior Factors after Principle Component Analysis** (Cronbach's Alpha noted for each factor<sup>2</sup>)

Company Directory Variables	Description of Coding
Distance between offices	<i>Same floor (1), same building (2), same work campus (3), same state (4), same country (5), or different countries (6)</i>
Peer relationship	<i>Whether subject and friend report to the same manager (1 vs. 0)</i>
Subject is a manager	<i>Subject is a manager or not (1 vs. 0)</i>
Friend is a manager	<i>Friend is a manager or not (1 vs. 0)</i>
Same division	<i>Whether subject and friend are in the same company division or not (1 vs. 0)</i>
Direct management	<i>Whether subject and friend have direct management relationship (1 vs. 0)</i>
Senior management	<i>Whether subject and friend are in the same management chain but not a direct reporting relationship (1 vs. 0)</i>

**Table 4. Company Directory Factors**

<sup>2</sup> Cronbach's alpha is a measure of how well individual variables vary, indicating the reliability of the single factor representing the multiple individual variables. Although some of our factors have low alpha values (< 0.7), we chose to keep the variables as grouped factors because they conceptually make sense together (e.g. content recommendations to and from friends) and the analysis found these variables to hold together more so than any other combinations.

**Predictors of Relationship Closeness**

As potential predictors of relationship closeness, we gathered data from Beehive’s server logs on user viewing and contributing behavior over the 12 months prior to the rating task. These logs provided activity information for both the subject and the subject’s friends, as well as the interaction between them and the subject’s and the friend’s interactions with their mutual connections. We also collected data from the company’s employee directory to gather basic organizational information such as office location and the hierarchical distance between each subject-friend pair.

53 variables from Beehive were collected. Because many of these variables were highly correlated with each other (multicollinearity), a Principle Component Analysis (PCA) was performed to produce a smaller set of uncorrelated variables (18 main factors with 74% of the variance explained) as shown in Table 3. The PCA process also transformed these variables from action counts, following power-law distributions, into standard normal distributions. The 18 factors used going forward fall into four categories: the subject’s behavior on the SNS, the friend’s behavior, the interactions between the subject and the friend, and the interaction the subject and the friend had with any mutual connections on the site.

The company’s employee directory provided additional information about the relationship between the subject and the friend: the hierarchical relationship, as well as relative physical location. Table 4 lists these individual variables with explanations of how these variables were coded, either as nominal or ordinal variables.

**Regression model**

After consideration of different models, in particular considering potential interaction terms between our factors, we settled on a linear regression model with only main effects because of its relative ease in interpretation (and unlike [12], including higher interaction terms did not boost our model’s performance). The model, with the four categories of SNS behavior factors, plus the company directory information, is represented as:

$$rs_{ij} = \mu + \alpha S_i + \beta F_j + \gamma M_{ij} + \zeta P_{ij} + \delta C_{ij} + \epsilon_{ij}$$

$rs_{ij}$  : relationship strength between subject i and his friend j;

$S_i$  : behavior factors for subject i;

$F_j$  : behavior factors for friend j;

$M_{ij}$  : mutual connection factors between subject i and friend j;

$P_{ij}$  : pairwise interaction factors between subject i and friend j;

$C_{ij}$  : corporation directory factors for subject i and friend j.

The information characterizing each subject’s and friend’s individual behavior (S and F in the model) was included in order to compensate for any violation of independence assumptions for regression models. Because Gilbert et al.

[12] found the presence of mutual friends to be an important predictor, we included a factor representing interaction with all mutual connections on the site (M in the model).

**RESULTS**

The 25 factors listed in Tables 1 and 2 (18 representing SNS behavior and 7 expressing the company directory information) were entered into the regression model in a stepwise method. This method found 10 significant factors contributed to general closeness, 11 contributed to the professional closeness, and 14 contributed to the personal closeness. For the purpose of comparison among these three questions, a superset consisting of these 17 factors were put into a regression for each of the three dependent variables and these results are presented here.

**Overall Model Performance**

Table 5 presents the overall results. The model predicts relationship closeness across all three questions with approximately 20-24% predictive power. The model performs slightly better when predicting general closeness and professional closeness strength. The Maximum Absolute Error (MAE), expressing prediction accuracy, indicates closeness can be predicted with 71-73% accuracy.

Because our research questions are focused on whether or not behavior on an SNS reflects relationship strength, it makes sense that both the subjects and the subjects’ friends should be active on the SNS for this detection to occur. By narrowing down the sample from 4009 subject-friend pairs to the 1614 pairs where the friends met our threshold for active on the site<sup>3</sup>, we significantly improved the model’s predictive power.

By just considering the active subject-friend pairs, the predictive power of the model increases to 28-34% and prediction accuracy improves 78-82%. Again, the model is strongest at predicting the general closeness and the professional closeness. In the analysis going forward, we focus on this active-pair subset.

Predictive Model		Relationship Strength Questions		
		General Closeness	Professional Closeness	Personal Closeness
Whole data set (N=4009)	Adj R <sup>2</sup>	0.244	0.242	0.201
	F-Stat	100.667	92.341	72.683
	MAE	0.28	0.27	0.29
Active-friends only (N=1614)	Adj R <sup>2</sup>	<b>0.312</b>	<b>0.338</b>	<b>0.280</b>
	F-Stat	<b>41.719</b>	<b>46.868</b>	<b>35.956</b>
	MAE	<b>0.22</b>	<b>0.18</b>	<b>0.22</b>

**Table 5. Model summary for whole data set and active-friends subset** (All p-value<0.001, MAE = Maximum Absolute Error)

<sup>3</sup> To remove inactive friends, we summed the three SNS behavior factors of each friend and those friends that fell below the mean (zero) were removed from the sample.

Standardized Beta Weights			
	General Closeness	Professional Closeness	Personal Closeness
<b>Subject's Behavioral Factors</b>			
Connecting	0.117**	0.175**	0.174**
General Activity	-0.005	-0.07*	0.049*
<b>Friend's Behavioral Factors</b>			
General Activity	-0.101**	-0.079*	-0.051*
Connecting	-0.062**	-0.042	-0.048
<b>Subject-Friend Interaction Factors</b>			
Explicit friendship	0.081**	0.077**	0.083*
Content Recommendations	0.232**	0.27**	0.237**
Recency and length of friend visiting subject's content	-0.145**	-0.134**	-0.157**
Subject viewing friend	0.05*	0.041	0.096**
Mutual profile commenting	0.067*	0.034	0.087**
Friend viewing subject	0.049*	0.018	0.04
Recency and length of subject visiting friend's content	0.074*	0.042	0.025
Mutual photo commenting	0.016	-0.017	0.037
<b>Mutual Connections Factors</b>			
Mutual connections	0.137**	0.085**	0.166**
<b>Company Directory Factors</b>			
Distance between offices	-0.216**	-0.128**	-0.201**
Same division	0.181**	0.25**	0.133**
Senior management relationship	0.052*	0.027	0.018
Direct management relationship	0.006	0.052*	0.016

\* .05 > p > .001    \*\* p < .001

**Table 6. Top Predictors of Relationship Strength.** (To simplify interpretation, we flipped the sign of original beta, so that a positive beta indicates a positive correlation to the closeness.)

The strongest predictors of relationship closeness across all three questions are 1) an explicit friendship link between the subject and the friend, 2) a subject's overall level of connecting behavior on the site, 3) the friend's general activity level (a negative relationship), 4) the length and recency of a friend's visits to the subject's profile (if the first visit was a long time ago and the last visit was recent, then the relationship is likely to be close), 5) a higher

number of content recommendations between the subject and the friend and 6) a higher number of interactions with mutual connections.

The negative correlation between a friend's general activity level and closeness on the SNS was unanticipated, but on reflection we believe it indicates that when a friend is very active on the site, communicating with many people, direct communication with the subject then becomes less of an indicator of closeness and more of an indicator of how the friend communicates with everyone on the site.

From the company directory factors, all three types of relationship closeness were stronger when physical distance was closer (a negative beta) and when the subject and friend were in the same company division.

Table 6 presents each of these significant factors with their standardized beta weights. The darker a table cell's shading, the more significant the factor is in the prediction model. With these findings, we have answered our first research question and determined which SNS behaviors are most predictive of relationship closeness in the workplace.

**Professional vs. Personal Closeness**

To answer our second research question about detecting the differences between professional and personal closeness, we focus in on differences between the beta weights for professional and personal closeness (the middle and right-hand columns of Table 6).

The results indicate that a subject viewing a friend's profile and friends and subjects commenting on each other's profiles are predictors of personal closeness, but not professional closeness. This suggests that personal friends check out and have profile-based conversations with those they feel personally close with, but not with those they have a professionally-focused relationship.

A second finding in terms of SNS behavior is regarding a subject's general activity level on the site. The switched signs on the beta weights indicate that the more active a subject is on the site, then the more personally close they feel with colleagues, yet the less professionally close they feel with them. This likely reflects earlier findings on Beehive that users typically connect on a personal level with colleagues on the site [8].

A direct management relationship between the subject and the friend is an important predictor of professional closeness, but not of personal closeness. Furthermore, a comparison of the beta weights for whether or not the employees are in the same division show that being in the same division is a much stronger predictor of professional closeness than personal closeness. These findings are not surprising in the sense that professional relationships are based on corporate hierarchy, not on personal affinity. Yet this result further confirms that professional and personal closeness are different concepts within the workplace, and these different factors can separate out the distinction between these relations.

In terms of the explanation power of the different categories of factors in the regression model, subject-friend interaction on the SNS is the dominant predicting term, followed by information from the company directory. Figure 2 shows the relative beta weights of each regression term, comparing the weights for professional vs. personal closeness.

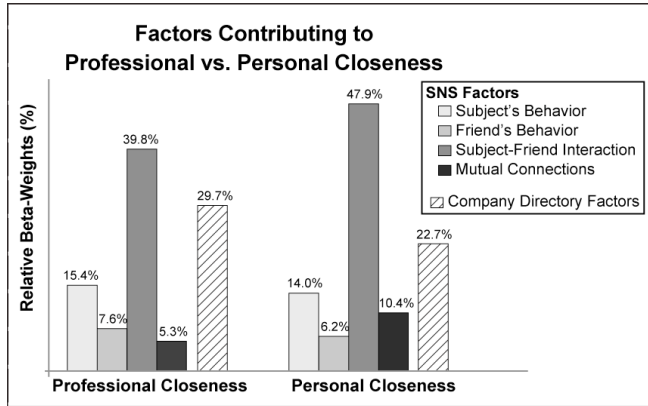


Figure 2. Predictive power of model factors. The weights are the percentages of the sum of the standardized coefficients.

This graph shows that, while the subject-friend interaction on the SNS reveals almost 50% of the information of the subject's *personal* closeness to a friend, this interaction predicts less than 40% of the *professional* closeness. Interaction with mutual connections indicates twice as much about personal closeness (10.4%) as professional closeness (5.3%).

In terms of the company directory factors, the directory contributes 29.7% of the predictive power for professional relationships, and 22.7% to predicting personal relationships. This supports the earlier discussion that hierarchical structure more heavily influences professional relationships than personal relationships.

**DISCUSSION**

Regarding our first research question, our results suggest that we can predict relationship strength within the workplace by studying interactions on an SNS. The strongest predictors of all types of relationship closeness are the distance between offices, whether two people are in the same division or not, whether there is an explicit friendship link established on the SNS, the subject's overall connecting behavior on the site, the friend's general activity, the length and recency of a friend's visits to the subject's profile, content recommendations between the pair and the amount of interaction with mutual connections.

Some of these predictors are pretty straightforward and expected, such as office location: people can be acquaintances from online socializing, but in order to be close friends *or* colleagues, physical proximity is still important. This explanation also applies to the finding that being in the same division is predictive of a close relationship.

Some of these predictors are less obvious, such as content recommendations between pairs. Yet when recommending site content to a colleague, you likely have some knowledge of that person's interests, either personally or professionally. This specialized knowledge about the colleague likely reflects a closer relationship with them.

Another unexpected predictor is that a friend's level of connecting on the SNS has a negative impact on the closeness between the subject and the friend. This may be explained because of a dilution of communication meaningfulness. Your friend may be an SNS enthusiast, who posts comments on everyone's profiles every day and connects to many more people than average on the site. When this person communicates with you on the site, because of their high activity level overall, the communication may not indicate closeness as much as it reflects the friend's general approach to using the SNS for connecting.

Some of our main predictors are consistent with Gilbert's previous work: they also found length and recency of friend communication to be top predictors of tie strength [12]. Both our results and theirs found that higher interaction with mutual friends was predictive of strong ties. Additionally, Facebook wall exchanges, the equivalent of our mutual profile commenting, was predictive of strong ties, as it predicted personal closeness in our model.

Focusing on our second research question relating to relationship multiplexity and the differences between professional and personal closeness, our regression model was able to make distinctions between these two types of relationship closeness.

	Strong tie	Weak tie
Professional Closeness	Direct management relationship between colleagues Colleagues are in same division	No direct management relationship between colleagues Colleagues are not in the same division
Personal Closeness	High levels of viewing of a colleague's content High levels of mutual profile commenting between colleagues Interaction with mutual connections	Lower levels of viewing of a colleague's content Lower levels of mutual profile commenting between colleagues Less interaction with mutual connections

Table 7. Predictors that distinguish professional closeness from personal closeness

For example, a direct management connection is a strong predictor of professional closeness, but not predictive of a personal relationship. This likely reflects the fact that employee-manager relationships are established through upper management decisions, not personal affinity between individuals. The model also found that users looking at and commenting on a friend's profile page was indicative of a close personal relationship, and not a close professional



relationship. In some ways, earlier analysis of Beehive discovered this through interviews when users claimed they did not use the SNS for keeping up with their “close colleagues” because they already had tools and mechanisms in place for doing this [7]. It may be that people use the SNS to keep track of those they care about on a personal level, but only intermittently visit the pages and content of those they are currently working with because they do not feel the need to keep up with their SNS activities.

Table 7 summarizes the factors that uniquely predict professional versus personal closeness, across the spectrum of tie strength.

#### Limitations

Beehive does not have private messaging and our analysis did not include any private communication between coworkers. In the workplace people frequently communicate through emails, instant messages, phone calls, and face-to-face meetings, in addition to intranet tools such as the corporate SNS. Because of this media competition, an analysis of just one resource, such as Beehive, underestimates the intensity of interaction between two persons. Combining information from multiple resources would improve a prediction model of workplace social network interaction.

In our model the workplace hierarchy and location heavily influenced the predictive power, which makes these findings more difficult to directly compare to findings with Facebook [12] or a non-corporate SNS, where there is no explicit management hierarchy and private communication does take place.

In terms of data collection, we chose to use a circular target for data collection for methodological and practical reasons, yet there are downsides to this method. For example, the participants could have found it difficult to determine relationship closeness while they dragged-and-dropped an individual image, requiring tedious readjustment. Information regarding angular layout, which may be part of a participant’s intentional communication (for example, grouping mutual friends together on the target), is lost in our current analysis.

#### IMPLICATIONS AND CONCLUSION

In our every day life, we interact with our colleagues, friends and family in different ways, depending on the nature of our relationship. And a relationship can be comprised of multiple facets, such as a family member who is also part of a circle of friends or a friend who is also a classmate. The workplace is one setting where these multiple facets are particularly present and complex because people both maintain professionalism and establish close friendships. This makes the workplace a particularly relevant setting for studying “relationship multiplexity.”

The popularity of using social network sites within the enterprise reflects the eagerness of employees to express themselves and share with each other, yet these sites are

also fraught with complex issues of identity management and self presentation [2, 6, 13]. While in the past work was done through paper documents and personal sharing was done around the lunch table or the water cooler, both work and socializing are now done within the digital domain of the corporate intranet.

The findings presented in this work provide new understanding of how employees communicate with their coworkers, by presenting a model for predicting professional and personal relationship closeness based on SNS behavior. These findings have implications for organizations, research on SNS behavior, and our understanding of relationship multiplexity.

First, organizations are interested in knowing the true social network structure of their organization because this information helps in management reorganization, project funding allocation, and other management-level decisions. By extracting the predictive factors from an SNS, organizations can detect relationships not reflected in the organizational chart. Such knowledge may help develop strategies for team formation. A complication with this issue though is that friends do not always make the best project teammates, because they tend to avoid conflict and excuse lower effort [24]. For individual employees, social network information can assist employees in finding jobs [14] and in spreading information between organizational divisions [16].

Despite the limitation of studying one SNS located within one company, the majority of the variables in the analysis are counts of actions common on SNSs: connecting, commenting, and viewing each other’s content. Our results align with Gilbert’s [12] and add to a continuing understanding of how behavior on an SNS can reflect relationship strength through factors such as profile commenting and mutual connections.

Our work also has implications for understanding online behavior as one facet of our lives. Relationship multiplexity is a natural part of relationships and balancing different, sometimes conflicting, personae becomes more difficult as online profiles are merging between different sites and with offline experiences. With knowledge of models that detect different relationship facets, designers of communication tools can incorporate natural segmentation of different communication styles and propose automatic filtering of certain communication for different audiences. Or alternatively, designers can leave the control up to the users and instead highlight when users are expressing multiplexity in their relationships. A greater sensitivity to relationship facets will improve the design of future networked applications.

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