

Email Effects on the Structure of Local Associations: A Social Network Analysis*

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Objectives. This article explores the impact of email on the network structure of small, voluntary associations. By focusing on the density and centralization of associations, we illuminate how the Internet affects their cohesiveness and democratic character. *Methods.* Based on network data collected from 41 community-based associations that are comparable on a variety of factors known to influence network structure, we employ multiple regression techniques to explore the impact of increased email use on group- and individual-level network measures. *Results.* We find that the technological nature of email as well as the background, interests, and intentions of its users interact to influence density and centralization. Individuals employ electronic mail differently from other communication modes such as phone and face-to-face communication. Network density increases, and network centralization either increases or decreases, depending on the distribution of email use in the association. *Conclusions.* These effects on associational structure are likely to have significant long-run impacts on the cohesion, efficacy, and democratic character of voluntary associations.

From the printing press to the Internet, people have recognized that the availability of new media of communication allow them to establish social ties that allow new forms of social organization (Bell, 1974; Beniger, 1986; Czitrom, 1982; Eisenstein, 1979; Fischer, 1992; Innis, 1951; Castells, 2000). A large and growing literature has focused on the impact of advanced information and communication technologies on formal organizations such as businesses and government bureaucracies, on the creation of new communities of interest, and on social interaction (Ahuja and Carley, 1999; DiMaggio et al., 2001; Katz and Rice, 2002; O'Mahony and Barley, 1999; Rheingold, 1993; Shklovski, Kiesler, and Kraut, 2006; Wellman, 1996; Wellman and Haythornthwaite, 2002).

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Nevertheless, as DiMaggio et al. (2001) argue, there has been little systematic study of how community-level voluntary associations use the Internet and whether it affects their structure and enhances their effectiveness. This gap in the literature is unfortunate because the communication capabilities offered by the Internet should be particularly useful to associational activities (Weare, 2002). Their members are geographically dispersed and they must balance associational activities with other commitments. In this situation, the asynchronous character of email and its ability to broadcast messages are especially useful for keeping members in contact. Given that there is evidence that communication between organizational members is a critical factor facilitating successful collective action, such structural changes are likely to affect organizational performance (Heckathorn, 1993; Macy, 1991; Sell and Wilson, 1991).

Social Networks

We approach the link between modes of communication and organizational structure from a social networks perspective. The distinguishing characteristic of social network analysis (SNA) is its focus on relationships between agents rather than on the characteristics and behaviors of individuals. By collecting data on both actors and their relationships with others, SNA permits analysis of organizational phenomena on a number of levels: (1) the individual level, (2) the dyad level, and (3) the level of the broader network structure. This approach offers distinct advantages for the study of organizational structure because social network scholars have developed a core set of stable and replicable measures of network characteristics that focus observation and facilitate comparisons. Two concepts, *density* and *centralization*, serve to describe the structure of social networks and are related to the *cohesion* and *democratic character* of associations, which are important factors to their performance. Density, the ratio of existing ties among group members to all possible ties, promotes cohesion, which furthers the development of common norms, bonds of trust, and social capital that promotes associational capacity (Coleman, 1988, 1990).¹ It also facilitates the diffusion of information in networks (Burt, 2000; Monge and Contractor, 2003; Rogers, 2003; Scott, 2000), which can improve capacity and reduce free riding (Cason and Khan, 1999; Heckathorn, 1993; Sell and Wilson, 1991).

Centralization is the extent to which a group's communication tends to flow through a specific person or persons rather than being more evenly distributed throughout all of its members (Freeman, 1979; Scott, 2000;

¹Wasserman and Faust (1994:251) list other components of cohesion, including the mutuality, reachability, and the relative number of outside group ties, but number of ingroup ties remains a central component of the measure.

Wasserman and Faust, 1994).² It captures the distribution of power within associations and the degree to which they enable members to participate in core decision-making functions (Ibarra, 1993; Krackhardt and Brass, 1994; Wasserman and Faust, 1994). Associations with low levels of centralization have a more democratic structure that distributes control over resources, maintenance of relationships, and information more evenly among their members (Skocpol, 1999). Verba, Schlozman, and Brady (1995) connect such decentralized structures with the acquisition of civic skills by their members.

Electronic Mail and Network Structure

The present study takes the approach de Sola Pool (1983) termed *soft technological determinism*—a concept that describes Castells's (2000) analysis as well. By reducing the costs of communication and changing the character of mediated communication (e.g., communication is asynchronous and low in social valence), email communication can change the structure and character of relationships. Castells highlights the Internet's ability to affect social networks by allowing people to search for and connect to individuals and organizations that otherwise would be impossible to find offline, establishing more "weak ties" (Castells, 2000; Granovetter, 1973). Email also can help individuals support large, dispersed networks and can overcome status barriers to communication (Wellman and Haythornthwaite, 2002; Sproull and Kiesler, 1986, 1991).

In particular, a significant feature of email is its broadcast capability. One person can send a single message to all others in a group without loss of fidelity, usually with no extra marginal cost. In contrast to radio and television broadcasting, email also allows message recipients to respond quickly to the entire group. Consequently, one email broadcast can generate additional communication throughout the network, further increasing density, and perhaps decreasing centralization as the whole network is activated. At the same time, the technical characteristics of email are not the only factors influencing communication patterns. Individuals differ in terms of their ability and inclination to use the Internet (Jung, Qiu, and Kim, 2001; Loges and Jung, 2001; Wood and Smith, 2001). We call these objective and subjective dimensions of Internet use *Internet connectedness* (Loges and Jung, 2001), and they also should impact the distribution of email use among group members.

²Several measures of centrality and centralization are commonly employed, each of which is associated with slightly different sources (or distributions) of prestige and power within organizations (Wasserman and Faust, 1994). The democratic character of voluntary associations is best captured by the measure of *betweenness*, defined as the extent to which a person serves as a link between two others seeking to communicate in a network.

Email and Network Density

Network density is constrained by the fact that the costs of establishing and maintaining ties remain constant while the added value of additional contacts decreases as they are more likely to provide redundant information (Burt, 2000). The introduction of the Internet to an existing social network should increase that network's density by mitigating these constraints.

It is noteworthy that the effect of email on group density is particularly strong for small, low-density networks, common characteristics of voluntary community organizations. In social network analysis, density for asymmetrical relationships is measured as:

$$\Delta = r/N * (N - 1) \quad (1)$$

Where: Δ = density

r = number of asymmetrical ties

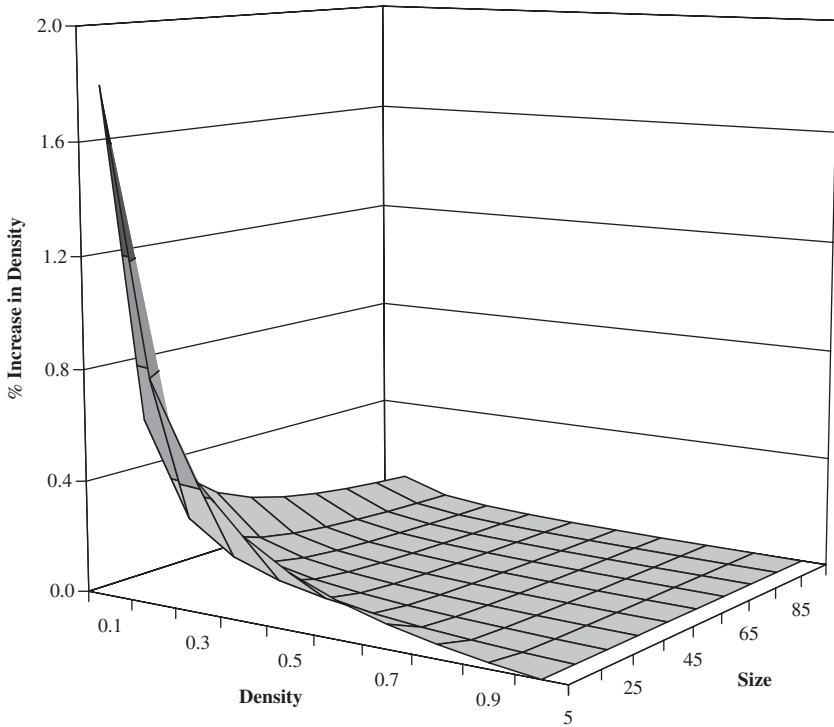
N = group size

One email message broadcast to the entire network on average leads to the creation of $(N - 1) * (1 - \Delta)$ new ties where the second term equals the average proportion of group members with which each member was previously in contact. The new density can be calculated by adding this number of additional ties to r in the numerator in Equation (1). The average percentage increase in density due to an email broadcast can then be shown to equal $(1 - \Delta)/N\Delta$. As seen in Figure 1, this percentage change decreases by an inverse function for both group size and prior density. An email broadcast has a noticeable impact, increasing density by 10 percent on a group with 24 members and a prior density of 0.3, but these effects diminish rapidly for larger or more dense groups.

Email and Network Centralization

The Internet is also likely to affect patterns of centralization within networks, but in contrast to density, the direction of change is not clear a priori. The use of email might increase centralization if one or a few members use email to broadcast to most other members of the network. To the degree that Internet use correlates with attributes that make an actor central to networks, such as high status and strong technical and communication skills, previously central members would become more central to a network when the Internet becomes available (Rethemeyer, 2002). Nevertheless, email may decrease network centralization if decreased costs generate more widespread communication throughout the network. Bikson and Eveland (1990) note that when groups with otherwise similar tasks differ in their access to email, those with access share leadership roles more than those without. Overall, existing empirical results support both causal directions, finding cases in

FIGURE 1
Percent Change in Density Due to an Email Broadcast.



which email use has both increased and decreased centralization (Ahuja and Carley, 1999; O'Mahony and Barley, 1999).

The broadcast capabilities of email are closely linked to its potential to either increase or decrease centralization. Imagine an organization with 15 members that communicate via a common telephone tree. To evenly distribute the coordination efforts to set up a meeting, one centralized person calls two individuals, each of whom calls two others, and so on. Email avoids the need for the phone tree, enabling one individual to distribute the meeting notice with a single broadcast to the entire group (e.g., a star network). As can be seen in Table 1, this use of broadcasting is clearly a centralizing technology, as a single message from one individual replaces 14 telephone calls. Emails, nevertheless, often elicit responses, and the overall impact of broadcasting messages then turns on the number of responses. Depending on the formal measure of centralization, it can take over eight responses to reduce network centralization below the level of the original tree. Given the varying results that can be produced with this simple example, it is not surprising that the literature on the centralizing effects of new communication technologies also has come to varied results.

TABLE 1
Simulation of Effect of Email Broadcasts and Responses on Group-Level Centralization in a 15-Member Organization

	Phone Tree	Star	Star+1 Response	Organization Configuration				
				Star+2 Responses	Star+4 Responses	Star+8 Responses	Star+14 Responses	
Density	0.13	0.13	0.26	0.37	0.57	0.86	1	
Betweenness centralization	46.47	100	39.08	20.72	7.06	0.78	0	
Closeness centralization	25.62	100	89.01	72.53	58.05	23.42	0	
Degree centralization	9.34	100	85.71	78.33	49.45	16.48	0	
Eigenvector centralization	40.02	100	60.49	42.01	22.87	6.45	0	

Based on this discussion, we propose five research questions to guide our analysis of the use of email in voluntary associations and its effects on associational structure. We avoid proposing hypotheses, given that the research into the effects of the Internet on the structure of social networks remains in its formative stages and has not produced consistent findings that allow for firm predictions.

RQ₁: *What factors are associated with use of email over other modes of communication?*

RQ_{2a}: *Does use of electronic mail increase the density of intra-association networks?*

RQ_{2b}: *Does use of electronic mail increase the size of individual networks (e.g., individual degree)?*

RQ_{3a}: *Does use of electronic mail increase the centralization of intra-association networks?*

RQ_{3b}: *Does use of electronic mail increase the centrality of actors in a network?*

Methods and Data

Participants

We explore these research questions employing a data set that includes social network indicators for a group of board members of neighborhood councils (NCs). In 1999, Los Angeles voters ratified a new charter that included provisions to create a system of neighborhood councils. Although officially considered organs of Los Angeles city government, neighborhood councils share many of the characteristics of informal associations. Other than requirements that neighborhood councils represent all stakeholders in their neighborhood and that they have an elected board, the charter ceded broad discretion to the neighborhoods in the design and makeup of their councils. In particular, each neighborhood was free to define its boundaries and develop its bylaws. The goal of the neighborhood council system is to provide more effective voice for citizens in city government. Although individual councils have particular goals, given the specific circumstances of their neighborhood, all NCs are meant to improve communication between various neighborhood stakeholders (e.g., renters, property owners, parents of children in neighborhood schools, and business owners) and between the neighborhood and city officials and departments. As such, effective and low-cost communications are vital to the mission of neighborhood councils.

The councils differ in many respects. They represent neighborhoods encompassing between about 11,000 to more than 85,000 residents, with an average population of about 40,000. These neighborhoods vary significantly in terms of socioeconomic and ethnic makeup, from very rich enclaves of primarily white homeowners to diverse mixes of poorer, less-educated recent

immigrants. The neighborhood council boards are composed of between 9 and 41 members, with an average of 20. The NCs that had organized the earliest had been certified by the city for 20 months at the time of our survey, while others had been certified for as little as seven months. In all cases, however, ad hoc committees had been working to organize neighborhood councils for many months prior to certification. The survey included elected board members, though this strategy excluded input from cases in which highly active NC members did not hold board positions.

At the time of our survey, 45 NC boards had been certified by the City of Los Angeles and had sitting elected boards. Because we were unable to get complete lists of board members from four boards, they are excluded from a number of analyses, though we use the individual-level data from those boards when appropriate.

Members of this research team personally visited board meetings and invited members to take the survey either online or by telephone in the summer of 2003. The survey was made available in English and Spanish. Out of 894 total board members, 587 respondents began the survey, for a response rate of 66 percent. Of these, 582 responses yielded usable network data, and 541 respondents had initiated contact with at least one other board member. In total, there are 3,141 communication dyads (including data from the four incomplete boards). Although this survey was designed to gather responses from all members of each eligible board, the response rate may be sufficient to estimate network characteristics with some confidence. Costenbader and Valente (2003) have shown that the measures of centrality employed here are fairly robust when response rates are higher than 60 percent within a network.

As shown in Table 2, these data indicate that NC board members are not typical of the average resident in the neighborhoods they represent. Consistent with earlier findings about political participation, NC board members are more commonly white, wealthy, older, well educated, homeowners, and long-time residents of their community (Verba, Schlozman,

TABLE 2
 Characteristics of Neighborhood Council Board Members

	<i>N</i>	Mean	Mode	<i>SD</i>	Minimum	Maximum
Income in dollars	500	74,320	110,000	32,856	10,000	110,000
Education (years)	565	15.8	18.0	2.1	10	18
Age (years)	558	51.1	49.5	12.6	16	68
Years lived in community	587	16.3	23.0	7.6	0.5	23
Interest in politics ^a	570	3.5	4	0.6	1	4
Liberal/conservative scale ^b	562	2.7	3	1.1	1	5
Uses Internet	563	93.1%				
Home Internet access	531	87.8%				

^aScale from 1 (none) to 4 (a great deal).

^bScale from 1 (very liberal) to 5 (very conservative).

and Brady, 1995). They expressed a high level of interest in politics, averaging 3.5 on a four-point scale from not at all interested to very interested. Their political views, however, did mirror the range of views of the entire city population, with most respondents expressing moderate views on a five-point scale between very conservative and very liberal.

Ninety-three percent of the board members accessed the Internet, and almost 88 percent had an Internet connection at home. Even on the least-well-connected board, 71 percent of its members were online and 67 percent had access at home. These results indicate a level of Internet connectedness higher than is usual in Los Angeles (Jung, Qiu, and Kim, 2001; Loges and Jung, 2001).

Measures and Methods

The questionnaire item of most importance to this article presented board members with a list of all other members of their NC board. They were then asked: "Thinking about the two weeks just before your most recent Neighborhood Council meeting, which board members were you in touch with during that time to discuss matters concerning politics, government, or neighborhood issues?" For those members with whom they had been in contact, respondents were asked whether they had been in contact by email, face-to-face, or by telephone. Multiple communication modes were accepted. Finally, the respondents rated the importance of contact with the other board member for their work on the NC.

Similarity among network members has been shown to affect communication patterns. For example, increased homogeneity is related to denser networks (Brass, 1995; Monge and Contractor, 2003; Rogers, 2003). Given the city's particular interest that the NCs represent diverse stakeholder groups, and reasoning that homophily of stakeholder representation might be grounds for closer ties, respondents were asked to which of the stakeholder groups the city wanted the NCs to represent they felt closest. These included such groups as homeowners, renters, employers, and property owners. Communication across ideological differences is another important aspect of democratic discourse (Huckfeldt, Johnson, and Sprague, 2004; Mutz, 2002). Thus, we also asked respondents to rate their political conservatism or liberalism on a five-point scale.

Other items in the questionnaire provided indicators of Internet connectedness, including measures of the respondents' confidence that they could perform a variety of tasks online, use of the Internet to gather information, and questions regarding the places from which they regularly have Internet access (e.g., home, school, their workplace, and libraries). These indicators were combined into a single scale measuring overall Internet connectedness.³ Demographic variables included age, education,

³Details on the construction of the scale are available from the authors.

household income, ethnicity, and length of residence in their community. In a number of analyses, the dyad is the basic unit of analysis. In the present study, dyad characteristics are determined by the average values for the ego and alter if data are available for both. If data are missing for one, the value for the available actor is substituted for the average.

Based on these data, we constructed sociomatrices for each NC with which we could calculate density and centralization scores. *Density*—the proportion of existing ties to all possible network ties in a network—is expressed as a ratio ranging from 0 to 1 (see Equation (1)). *Betweenness centrality* is an individual-level variable defined as the extent to which a person serves as a link between two others seeking to communicate in a network. It is normalized to control for network size and ranges from 0 to 100. Network-level measures of centralization are derived from the sum of squared differences of each actor's centrality in comparison to the most centralized actor in that network. These scores are also normalized as a percentage of the most centralized network possible (e.g., a star network) and range between 0 and 100.

To analyze how modes of communication affect communication patterns, we employ ANOVA to examine the differences in dyad characteristics between each mode. Then we employ standard OLS techniques to analyze the factors that lead to group-level density and centralization and to individual-level network size and centrality.

Results

As is expected with informal organizations, the degree of individual involvement varies markedly. The average NC board member was in contact with about 38 percent of the other board members (Table 3). The number of contacts, however, was skewed to the right by the small number of board members who were most in touch with others. Less than 5 percent of board members contacted more than 85 percent of their colleagues, and this group accounted for over 19 percent of all contacts. Normalized network centrality varied accordingly, with an average of 4.9, but a maximum of 80.36. Only about 10 percent of board members had a normalized centrality score above 10. At the board level, the average density was 0.37, with a high of 0.65 and a low of 0.14. Normalized centralization averaged 27.8 percent and ranged between 3.6 percent and 79.7 percent.

Email and Patterns of Communication

Our general interest is in whether use of email within a network is associated with different patterns of communication. Because we only have cross-sectional data, our ability to discern the causal effects of a new communication mode is limited. Most importantly, we are unable to control for

TABLE 3

Network Characteristics of Neighborhood Council Board Members and Boards

	<i>N</i>	Mean	<i>SD</i>	Minimum	Maximum
<i>Individual-Level Characteristics</i>					
Percent of board members contacted	495	38.2%	25.1%	0.0%	100.0%
Normalized betweenness centrality	536	4.91	8.92	0	80.4
Percent of links by email	494	35.5%	28.1%	0.0%	100.0%
Percent of contacts reached by email	495	53.3%	38.2%	0.0%	100.0%
<i>Board-Level Characteristics</i>					
Density	41	0.37	0.11	0.14	0.65
Betweenness centralization index	41	27.82	14.36	3.58	79.69
Percent of links by email	41	34.7%	12.9%	6.0%	58.0%
Percent of contacts reached by email	41	53.2%	22.1%	7.0%	90.0%

the structure of intra-organizational communications in the absence of email and for the degree to which email substitutes for or complements existing modes of communication.

Our analysis, thus, is based on a counterfactual. If the characteristics of communication modes such as email have no effect on the choice of mode and the pattern of communications (e.g., if communication modes are chosen randomly), then the proportion of ties devoted to a particular mode should not differ significantly in subsets of dyads with differing characteristics. Similarly, one would expect the structure of ties to be similar in the networks described by the alternative modes. To the extent that email does have effects, we should observe statistically significant differences, though these are obscured by unobserved differences in preexisting communications networks and the pattern of substitution between communication modes. Employing this strategy, we investigate how characteristics of individuals, groups, dyads, and communications are associated with their reliance on email communications.

Our findings do show that email plays a central role in intra-group communication for these organizations. Twenty-one percent of communications between board members are mediated solely by email, and in 58 percent of all dyads, email is at least one of the communication modes employed. There is a distinct bimodal distribution in the degree to which individuals rely on email. Over 14 percent of board members have no contacts with others by email, while 16 percent have employed email communication with everyone with whom they have been in contact. The remaining 70 percent are uniformly distributed between these two extremes.

There are clear differences in the manner in which email is used in comparison to other modes. As seen in Table 4, dyads composed of social

TABLE 4
Use of Email by Dyad Characteristics

Characteristic	Dyad Type ^a	Communication Mode		
		Only Email	Both Email and Offline	Only Offline
Income**	Low average	17.4	32.2	50.4
	High average	25.5	43.1	31.4
Stakeholder difference*	Same group	23.5	46.6	29.9
	Different groups	20.3	40.6	39.1
Ideological difference*	Same position	23.9	46.5	29.6
	Somewhat different	23.0	40.1	36.9
	Different	19.5	42.7	37.8
	More different	15.5	43.5	41.0
Importance*	Most different	15.8	15.8	68.4
	Not at all important	34.8	11.2	54.0
	Somewhat important	32.9	20.7	46.5
	Important	25.3	29.0	45.6
Associational tenure**	Very important	17.4	41.3	41.3
	Low average	21.3	41.7	37.0
	High average	21.2	31.1	47.7
Internet connectedness	Low average	21.3	37.2	41.5
	High average	22.0	41.7	36.2
Neighborhood population	Large neighborhood	19.1	46.1	34.8
	Small neighborhood	22.5	38.1	39.4
Board size	Large board	21.8	40.3	37.8
	Small board	19.8	43.9	36.3

^aExcept in the case of the homophily variables, dyads are divided into groups into high and low values at the median value.

*Significant at the 0.05 level.

**Significant at the 0.01 level.

and economic elites rely more on email. Dyads that connect higher-income board members are more likely to be mediated by email, either exclusively or in addition to other communication modes.⁴ Contacts between differing individuals are also less likely to be mediated by email alone or a combination of email and offline communications. These results pertain to whether difference is defined by identification with a stakeholder group or placement on a liberalism/conservatism scale. For example, contacts in over 70 percent of the dyads composed of individuals with like ideologies are

⁴The network data analyzed in these comparisons violate the independence assumption for chi-squared tests because multiple contacts are associated with a single individual. To control for these effects, we employ a specialized boot strap method, called the quadratic assignment procedure, to empirically derive the distribution of the test statistic under the null hypothesis (Krackhardt, 1988). We gratefully acknowledge the Harvard Business School and William Simpson for sharing their Stata program that implements the quadratic assignment procedure.

mediated by email alone or in addition to phone or face-to-face contact, but only 31.6 percent of dyads composed of a very conservative and a very liberal individual are mediated by email. The perceived importance of a communication is clearly associated with individuals' choice of communication mode.⁵ The proportion of dyads that employs only email decreases steadily as importance increases, while when employing multiple modes, increases steadily.⁶

In contrast, dyads composed of individuals who have been involved with the board for a longer time tend to rely less on communications solely by email and have more frequent face-to-face contact. Contrary to expectations, a number of factors did not have an effect on choice of communication modes. Dyads connecting individuals who score more highly on Internet connectedness are only slightly more likely to communicate via email and this difference is not statistically significant. Similarly, the number of members on a board and the size of the neighborhood it represents did not increase reliance on email communications.

Email and Associational Density

Research Questions 2a and 2b involved the relationship between email use, the network density of associations, and the size of personal networks within the association. Given that over 22 percent of all contacts in our sample employ only email communications, it is not surprising that email appears to increase the density of NC board networks. If we assume that all email-based communications constitute new contacts that would not have occurred in the absence of the availability of email (an assumption that will be dropped later), the addition of email to offline forms of communication increases the density for almost all boards. The increase in density between the networks constituted with only offline communications and those including email contacts ranges from 0 to more than 0.30. The average increase of 0.076 is substantial. The average board in our sample has 20 members and an offline density of 0.3, indicating that 57 of the 190 possible links between board members exist. The email network, when added, creates 14 new links between board members, on average.

This evidence is not unequivocal. Because these cross-sectional data lack information on prior levels of communication, it is not known to what degree the observed email communications simply substitute for phone calls or face-to-face discussions. Nevertheless, the fact that email is employed

⁵In this analysis, relationships are treated as directed ties in which ego ranks the importance of alter.

⁶This result is reinforced by examining communications with contacts that occupy more central positions within the organizational networks. When board members contact highly central actors, they are more likely to employ a combination of email and other communication modes. In contrast, there is no association between the centrality of the survey respondent and his or her choice of modes of communication.

differently from other communication modes supports, to some extent, the interpretation that email does constitute new links. Statistical controls can clarify the relationship within cross-sectional data. The standard method employed in the Internet and sociability literature is to regress a general measure of Internet use on a measure of the number of social contacts, controlling for variables that affect communication (Shklovski, Kiesler, and Kraut, 2006). This method can rule out sources of spurious correlation and is the best option available given current data.

For this analysis, the dependent variable measuring group density is mean degree (i.e., the mean number of connections among members of a board) because it is less sensitive to group size than the standard density measure. In addition, to control for response-rate effects, mean degree is adjusted by the proportion of ties for which no data exist due to survey nonresponse. Control variables include standard measures of the average socioeconomic status of board members, the length of time the board has existed, and measures of previous organizational activity. Group size is also included in one variant of the model.

The measure of Internet use is the Internet Connectedness Index (ICI), which combines measures of the scope of Internet use and Internet skills. A question arises, however, on how to aggregate individual levels of Internet connectedness to the group level. One hypothesis is that the average level of Internet connectedness among association members is the key determinant of group density. This hypothesis assumes that the contribution of connectedness to density is additive and each member's connectedness contributes something. Alternatively, group density may be a function of the Internet connectedness of the most highly connected members. This hypothesis assumes that due to the broadcast nature of email, only a few Internet-savvy members are needed to tie the group together through email. Both these hypotheses were tested in regression models, one with group size included as a control variable and one without. The results of the four models are displayed in Table 5.

The most striking result, as seen in Models 1 and 2 of Table 5, is that average ICI score among board members has no impact on mean degree density. In contrast, Models 3 and 4 provide at least weak support for the proposition that the number of highly Internet-connected individuals does increase group density. In Model 3, the number of high-ICI individuals is a highly significant predictor of density, though when group size is added in Model 4 the impact of the number of high-ICI individuals diminishes and the coefficient becomes only marginally significant. These results may indicate spurious correlation; larger boards may have higher mean degree since there are more members with whom one may speak and they are more likely to have a larger number of highly connected individuals. Nevertheless, the fact that the ICI coefficient remains significant, if only marginally, suggests that high-ICI individuals still have an independent effect on the density of a network.

TABLE 5
Board Network Density as a Function of Internet Use

	Model 1	Model 2	Model 3	Model 4
Average age	-0.256	-0.303**	-0.055	-0.175
Average education (years)	0.323**	0.127	0.254*	0.119
Months since NC officially recognized by city	0.202	0.178	0.247*	0.204*
Average number of organizational memberships	-0.013	0.012	-0.059	-0.023
Average hours of volunteer work	0.511***	0.422***	0.508***	0.431***
Number of board members with high Internet connectedness (top quintile)			0.414***	0.225*
Average Internet connectedness	0.071	0.006		
Board size		0.547***		0.472***
Adjusted R^2	0.361	0.611	0.479	0.642

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed tests).

NOTE: Coefficients are standardized betas. Dependent variable: mean degree adjusted for survey response rate. $N = 41$.

In contrast, when focusing on the individual level, email does not appear to increase the size of individual networks. We model the number of board contacts for each individual (degree) as a function of demographic characteristics, political activities, and Internet connectedness. Individuals on larger boards, not surprisingly, have more contacts. Also, prior political activities predict larger personal networks, but when controlling for other factors, Internet connectedness does not increase the size of individual networks.

TABLE 6
Predictors of Individual Network Size

	Model 1	Model 2
Age	-0.017	-0.012
Education (years)	0.017	-0.013
Months since NC officially recognized by city	0.071	0.076
Months of involvement with neighborhood council	0.115**	0.130***
Number of organizational memberships	0.066	0.060
Hours of voluntary work	0.166***	0.154***
Internet connectedness	0.070	0.062
Board size		0.235***
Adjusted R^2	0.066	0.118

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed tests).

NOTE: $N = 433$. Coefficients are standardized betas. Dependent variable: node degree.

Organizational Network Centralization and Actor Centrality

Research Questions 3a and 3b concerned the relationship between email use and network centralization and individual centrality. As the empirical literature has found and we have argued theoretically, the relationship between the use of email and group centralization is not unidirectional. An important contingency factor is the distribution of Internet use among group members. A single or only a few users who employ email lists to broadcast messages can increase centralization. This effect is countered by the degree to which the lower communication costs associated with email decrease the burden of maintaining redundant ties, leading to more dynamic communication exchanges between a larger proportion of organization members.

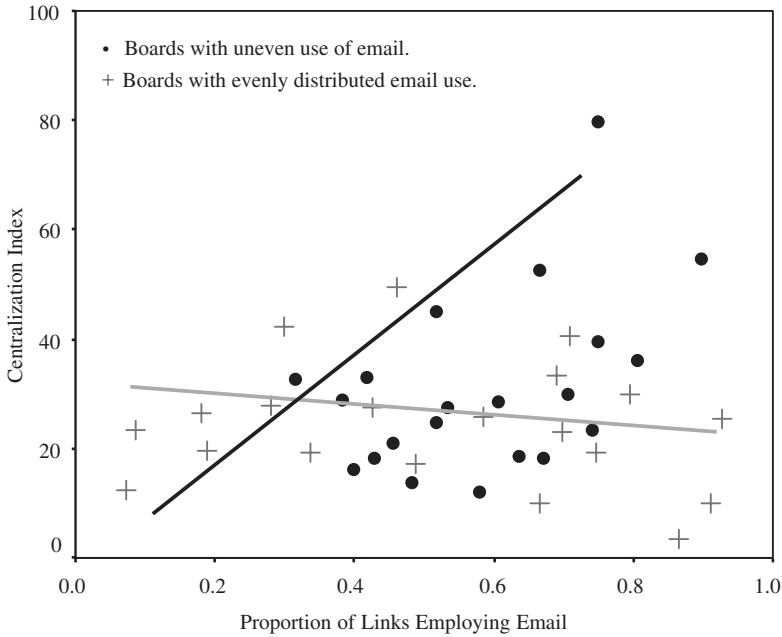
The importance of the distribution of Internet use within an organization is evident in these data. We calculate a measure of the change of centralization due to email communications. It equals the betweenness centralization index for each board, including all contacts minus the centralization index for only offline communications. The results vary widely. The median change is zero, but the range is from a decrease of almost 20 percent to an increase of 75 percent, with a standard deviation of 15.8.

As seen in Figure 2, boards that rely more heavily on email are not, on average, more or less centralized, but the *variance* in their members' levels of centralization increases.⁷ When we differentiate between boards with more or less equal distribution of email use among individual members, the importance of the variance as an intervening variable becomes clear. As seen in the scatter plot and regression results, among boards in which email use is distributed relatively evenly, increased reliance on email within the board has little impact on centralization. In contrast, in boards in which members vary more in their use of email, increased reliance on email leads to a marked increase in centralization.

In contrast to these results on group centralization, email use does not appear to have a significant effect on individuals' centrality within their neighborhood council boards. The correlation between individuals' centrality within networks of offline communications and their centrality within online communications is relatively low, only 0.31. This finding suggests that the advent of email could be enabling some individuals to rise in centrality within associations. However, email communication does little to alter the core of individuals who appear to control these neighborhood councils. In 17 of 41 boards, the five most central actors are also the five most central in the offline network, and in another 16 boards only one of the five most central actors was not in the top five in the offline network. In

⁷For boards with below median proportion email links, the average centralization index is 26.3 with a standard deviation of 10.2. For those boards with above median proportion of email, the average centralization index is 29.3 with a standard deviation of 17.6. The difference in the means is not statistically significant, while the difference in variance approaches significance at the 0.10 level.

FIGURE 2
Board Centralization as a Function of Email Use



DV: Centralization Index	Standardized Beta	t Score
Proportion of email use in board	-0.077	-0.451
High SD of email use	-1.13**	-2.33
High SD * Proportion of email use on board	1.47***	2.87

** $p < 0.01$; *** $p < 0.001$ (two-tailed tests).

NOTE: $N = 41$. Adj. $R^2 = 0.194$.

only one board was it the case that all five of the most central actors were not among the most central members in the offline network.

Discussion

Theorists have linked the development of large-scale organizations and other social structures to developments in information technology (Bell, 1974; Beniger, 1986; Castells, 2000; Innis, 1951; Pool, 1977, 1983). However, they often have little to say about the micro- or meso-level processes that must accompany the macro-level social changes they describe. Our results on the micro-level organizational impacts of information

technology provide qualified support for these broader claims on the social influence of information technology, but we find that the effects of email do not necessarily lead to more democratic structures.

Technology does matter. Individuals do consider email to be a distinctive communication mode and employ it differently from other modes. Use of email is associated with patterns of network density and centralization—patterns that appear to be related to the technological nature of email. The Internet does not merely duplicate existing media of communication. Over 20 percent of the contacts between board members consist solely of email exchanges, suggesting that email expands communications, in contrast to previous work on policy networks that argues that it merely replicates existing communication patterns (Rethemeyer, 2002). Communications that are deemed less important and more routine are more likely to take place online. Similar people also communicate online more often than differing others.

We also find that email use is correlated with the density of associations. To the extent that increased density helps associations maintain contact, disseminate information quickly and efficiently, monitor the actions of members, and forge social bonds that prepare them for the give and take of neighborhood-level politics, new technology has the potential to mitigate a fundamental obstacle to group cohesion and collective action. This shift has the potential to strengthen and expand the role of associational activity in a wide range of social arenas such as urban governance and nonprofit service provision.

A few board members with high Internet connectedness can increase the density of the entire board even though most individual members show no significant increase in the size of their personal networks. This result, at first, appears incongruous. How can email increase the density of organizations without increasing the size of personal networks? The result, nevertheless, can be explained as a manifestation of the broadcast capabilities of email. A single email broadcast from one member increases group density, but this group-level phenomenon is attributed to the actions of one individual. Those few individuals who broadcast emails, however, do not appreciably affect the overall relationship between individual-level email use and individual network size.

This interpretation is borne out by the evidence. Wide use of email is relatively rare. Only 18 out of 522 board members (3.4 percent) contact 85 percent or more of their board through email. Email is clearly preferred when one wishes a broad reach. Only two members contacted 85 percent or more of their board by phone and only six did so face-to-face. These individuals who employ email broadly, moreover, are associated with those boards for which email increased their density most. Of the 10 boards that had the largest increases in density associated with email, eight had at least one member who contacted at least 85 percent of the board by email. In contrast, of the other 31 boards, only six included such an email broadcaster.

Further research, nevertheless, is required to identify the specific role that email plays in organizational activity. We find, for example, that the propensity to use email for board-related communication decreases as tenure in the association grows longer. This tendency suggests that email is more helpful for forming initial ties within the association than it is for maintaining these ties on an ongoing basis. Associations like NCs in Los Angeles begin with no routine tasks, no clear role definitions, and no specific times and places at which the group will meet. As the association matures, routines and roles stabilize. The Internet appears most helpful in the early, somewhat chaotic, phase of association life—what population ecologists term the challenges associated with liability of newness (Hannan and Freeman, 1984), and less helpful as routines become established.

The present study of associations that are by their very definition geographically bound finds that the Internet remains relevant even to associations based on geographic proximity rather than other common interests. However, unlike communities that exist only in cyberspace, the neighborhood associations presently studied tend to move out of a phase in which email is important to their development, and to rely on familiar modes of interaction as time passes. Thus, further research focusing on the evolution and lifecycle of such associational networks could contribute significantly to the existing body of knowledge.

Our findings also support the utility of employing a soft technological determinism perspective given that we find that individuals' goals, skills, and social context do influence the use and impacts of technology. It is not the mere use of email that centralizes an association, but the distribution of people with various levels of skill and inclination to use the Internet that makes a difference in centralization. To the extent that democratization and decentralization are similar and reinforcing concepts, the findings indicate that the Internet will foster democratic associations only if the people in these associations have similar levels of Internet connectedness. In this way, Internet connectedness becomes akin to a civic skill. It also implies a digital divide problem—people with less Internet use (for whatever reasons) may be able to join an NC, but not as able to become a central player in the NC, thereby receiving information later and less reliably.

It also appears that email reinforces individuals' tendencies to form social connections with like-minded others. Homophily of interests and political outlooks among subsets of board members may, over time, create cliques. Such subgroups would not necessarily be observed through their face-to-face or telephone communication, but by Internet communication that is not as observable to other members of the association. If email exchanges allow cliques to form and to harden their stances on contentious issues that the board faces, this may be counterproductive.

This study's design also facilitated the analysis of phenomena at multiple levels of analysis: the individual, the dyad, and the group. Such multi-level analysis proves critical because some phenomena are only observable at the

group level. Individual-level phenomena that manifest themselves in few people and are, therefore, difficult to analyze statistically have consequences for the whole association.

Some disadvantages, nevertheless, suggest opportunities for further research. The sample, limited to neighborhood associations in Los Angeles, calls for caution in generalizing these results to other networks, especially less formal networks (e.g., of friends). The cross-sectional data also call for caution in interpreting causal relationships and in drawing conclusions about how long lasting the relationships may prove to be. Finally, the Internet remains a moving target. The range of things that is possible to do online and the number of people online is constantly changing. It was by no means evident in 1984, let alone 1994, that 93 percent of council board members throughout the diverse neighborhoods of Los Angeles would be using email. The research questions explored in this study will bear revisiting in other kinds of networks and as technology advances. In particular, the collection and analysis of longitudinal data of associational use of communication will help clarify the micro foundations of technological social change.

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