

## INNOVATION IMPACTS OF USING SOCIAL BOOKMARKING SYSTEMS<sup>1</sup>

**Peter H. Gray**

McIntire School of Commerce, University of Virginia, 345 Rouss & Robertson Hall, East Lawn,  
Charlottesville, VA 22904-4173 U.S.A. {pgray@virginia.edu}

**Salvatore Parise and Bala Iyer**

Technology, Operations and Information Management Division, Babson College,  
Babson Park, MA 02457-0310 U.S.A. {sparise@babson.edu} {biyer@babson.edu}

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*Many organizational innovations can be explained by the movement of ideas and information from one social context to another, “from where they are known to where they are not” (Hargadon 2002, p. 41). A relatively new technology, social bookmarking, is increasingly being used in many organizations (McAfee 2006), and may enhance employee innovativeness by providing a new, socially mediated channel for discovering information. Users of such systems create publicly viewable lists of bookmarks (each being a hyperlink to an information resource) and often assign searchable keywords (“tags”) to these bookmarks. We explore two different perspectives on how accessing others’ bookmarks could enhance how innovative an individual is at work. First, we develop two hypotheses around the idea that quantity may be a proxy for diversity, following a well established literature that holds that the more information obtained and the larger the number of sources consulted, the higher the likelihood an individual will come across novel ideas. Next, we offer two hypotheses adapted from social network research that argue that the shape of the network of connections that is created when individuals access each others’ bookmarks can reflect information novelty, and that individuals whose networks bridge more structural holes and have greater effective reach are likely to be more innovative. An analysis of bookmarking system use in a global professional services firm provides strong support for the social diversity of information sources as a predictor of employee innovativeness, but no support that the number of bookmarks accessed matters. By extending the social networks literature to theorize the functionalities offered by social bookmarking systems, this research establishes structural holes theory as a valuable lens through which social technologies may be understood.*

**Keywords:** Social tagging systems, social bookmarking systems, social technologies, Web 2.0 technologies, Social network analysis

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*I look to see who the other people are on del.icio.us who tag the same things that I think are important. Then, I can look and see what else they've tagged ....And isn't that part of the collective intelligence of the Web? You meet people who find things that you find interesting and useful—and that multiplies your ability to find things that are interesting and useful, and other people feed off of you.*

– Howard Rheingold

## Introduction

Innovation has historically been a strong driver of organizational success (Kim and Mauborgne 1999), with superior financial performance often found amongst firms that have a high propensity to innovate (e.g., Fenney and Rogers 2003; Roberts 1999). While some innovations involve fundamental scientific breakthroughs, many innovations are the result of recombinations of existing ideas in new contexts (e.g., Schumpeter 1934; Weick 1979). The history of innovation is littered with discoveries that arise from fortuitous interactions between individuals who were unaware that their separate efforts had mutual relevance (Hargadon 2002).

Such happenstance interactions have value precisely because they are not widespread; if all employees in an organization communicated constantly with each other, then there would be no isolated pockets of information waiting to be discovered. But employees tend to focus their attention on a limited subset of colleagues (Cross and Sproull 2004), and often develop relatively stable networks of contacts that limit the range of information to which they are exposed (Allen 1970). Social network theories hold that while each interaction with a colleague has the potential to yield new information, interactions with those who are socially distant are more likely to do so (Burt 1992). This is the case, in part, because individuals who interact infrequently are more likely to obtain information from different sources (e.g., Granovetter 1973).

Many different information technologies may help reduce the effort that is necessary for employees to expand their range of information sources across an organization, including electronic discussion groups (Constant et al. 1996), online communities of practice (e.g., Goodman and Darr 1998), knowledge repositories (Alavi and Leidner 2001), and expertise locators (Davenport and Glaser 2002). Despite the ostensible appeal of such technologies, employees often are hesitant to invest energy in sharing their personally held information and knowledge (Constant et al. 1994; Dyer and McDonough 2001; McDermott 1999). The ideal solution to this thorny motivational problem would be a technology that helped others without requiring any extra effort on the part of a contributor, but for many years researchers expressed skepticism about whether such a system would even be possible (e.g., Markus 2001). However, new technologies, known as social

bookmarking systems, may squarely address the effort investment problem by allowing individuals to easily discover what online information sources others find interesting and useful. These systems let individuals create bookmarks (each is a link to an underlying digital resource) and assign metadata (keywords, or “tags”) to them; others can search on tags to discover bookmarks that lead to the underlying information resource (Hammond et al. 2005). Within organizations, they can be used to see what colleagues have recently read and found interesting (Green 2005; McAfee 2006), requiring no extra effort on their part to allow others to see their bookmarks.

We are aware of no published research that theorizes or assesses the effects of social bookmarking system use on individuals. Indeed, many IT managers are skeptical about whether social bookmarking systems benefit employees (Hoover 2007), and find it difficult to articulate a compelling value proposition for their adoption (e.g., Gardner 2008). Research that can situate social bookmarking systems in a body of theory and produce evidence to help IT managers and researchers understand the benefits users might obtain (and what kinds of behaviors are more likely to produce those benefits) is thus likely to advance both research and practice.

## Social Bookmarking Systems

All web browsers have features that help individuals organize their bookmarks. Increasingly, browsers are including features that let users assign tags, or self-selected keywords, to their bookmarks (Marlow et al. 2006), and search through their tags and associated bookmarks in ways that were not possible with older, hierarchically organized bookmark lists (Hammond et al. 2005). Social bookmarking systems such as del.icio.us and Technorati take this functionality and place it in a public venue, so that that each individual's tags and bookmarks are visible to others as well (Guy and Tonkin 2006). The aggregation of all tags across individuals has been termed a “folksonomy” (Noruzi 2006)—a user-generated informal taxonomy that is meaningful to users because it reflects their own terminology (Golder and Huberman 2006).

A bookmark can be made visible to others if a user chooses to make it public; however, the act of accessing a bookmark in

contemporary social bookmarking systems is not visible to others at all. Social bookmarking systems, therefore, let individuals unobtrusively discover what others are reading in two ways. First, an individual can search on a certain tag to find what bookmarks others have associated with it. Second, an individual can view the complete set of tags and bookmarks created by another person, which makes it possible to serendipitously come across information that is interesting and relevant but which users may not have known to search for directly. Together, these are “social navigation” (Dieberger 1997), where one individual’s choice of which online resources to visit is influenced by the prior actions of others. Social bookmarking is thus an exemplar of the participatory nature of Web 2.0 technologies (O’Reilly 2005), where value is created for all users through the aggregation of individual efforts (McAfee 2006).

## Theory

Below, we offer four hypotheses to explain how social bookmarking systems may enhance employees’ innovativeness when they (1) access larger numbers of bookmarks, (2) access the bookmarks of larger numbers of people, (3) access the bookmarks of people who are less likely to provide redundant information, and (4) access the bookmarks of people who themselves are exposed to more nonredundant information via their own use of a bookmarking system. The core behavior of interest involves an individual accessing another’s bookmarks, either by searching or browsing to locate a tag through which they can access his or her bookmarks, or by searching or browsing to locate an individual by name and then accessing that person’s bookmarks. We seek to predict *personal innovativeness*: the extent to which an individual actively generates, discovers, and promotes creative ideas. Several antecedents may affect personal innovativeness, with recent reviews by Shalley et al. (2004) and Egan (2005) suggesting that characteristics both of individuals and their work contexts may influence how innovative an individual is. In organizations, managerial style (Zhou and Shalley 2003), job complexity (e.g., Tierney and Farmer 2002), and leader behaviors (Redmond et al. 1993) may also affect employee innovativeness. While such factors may influence information-seeking behavior, none are threats to the idea that an individual’s pattern of informational connections influences his or her innovativeness (for an extended discussion and evidence on this point, see Burt 2005, pp. 64-92).

### Quantity as a Proxy for Diversity

Consistent with research that theorizes a positive relationship between system use and individual impacts (e.g., Clark et al.

2007; DeLone and McLean 2003; Seddon 1997), we first consider how more extensive information searches are likely to enhance innovativeness.

Our first hypothesis concerns the number of bookmarks that an individual accesses. Because individuals create bookmarks to keep track of digital resources that they find to be interesting, the more frequently an employee accesses others’ bookmarks, the more organizationally relevant information he/she is likely to obtain. The functionality offered by social bookmarking systems provides individuals with a variety of ways of finding out what digital resources were interesting to other users (Golder and Huberman 2006), including clicking on others’ tags and navigating to their bookmark lists directly. Many social bookmarking systems also track changes to others’ bookmarks, with RSS feeds to notify an individual when a new addition is made (McAfee 2006). Using a social bookmarking system is thus an information discovery process, guided by observations of how others structure their digital resources, that may result in serendipitous new insights (MacGregor and McCulloch 2006). Employees who make more frequent use of the bookmarking system will reach more content than those who make less frequent use of it. If some proportion of that content could be novel to an employee, then the more bookmarks accessed, the greater the chances of finding something novel.<sup>2</sup> As described in the literature on environmental scanning (e.g., Choo 1998; El Sawy 1985; Saunders and Jones 1990), when faced with uncertain or ambiguous tasks, individuals benefit from accessing larger amounts of information. Broader searches that reveal more novel information (Thomas and McDaniel 1990) can enhance the creativity of the solutions individuals produce (Vandembosch and Higgins, 1996).

*H1: The number of times an individual accesses social bookmarks will positively predict his/her level of personal innovativeness.*

Our second hypothesis concerns the number of different people who created the bookmarks that an individual has accessed. For H2 and the remaining hypotheses, we conceptualize a connection as occurring when one person accesses another person’s bookmarks, either by having clicked on a tag that leads to his/her bookmarks, or by clicking on an indi-

<sup>2</sup>While the number of times an individual accesses bookmarks may not be a perfect proxy for the amount of novel information obtained, it is consistent with our goal of relating system use behaviors to innovativeness. Future research may seek to theorize indicators of information novelty in finer detail, including more aspects of information that might be indicators of novelty (such as document uniqueness, document length, document age, overlap in content with other documents obtained, amount of time spent reading it, etc.).

vidual by name and then accessing his or her bookmarks. A range of research on interpersonal information sources supports the idea that individuals who interact with a broader range of others are exposed to a greater range in perspectives from different functional areas, tenure bands, skill sets, and knowledge bases, which in turn may result in greater creativity and innovativeness (e.g., Pelled et al. 1999; Perry-Smith 2006). Thus, while H1 holds that the odds of finding something new increase each time the system is used, there may be a significant difference, for instance, between accessing bookmarks all made by a single individual and accessing the same number of bookmarks that were each made by a different individual. Each person's set of bookmarks reveals the documents he/she has been reading and the way in which he/she has chosen to organize them (Millen et al. 2006), and thus provides something akin to a concept map (Novak and Gowin 1996) that reflects how he/she perceives and organizes his/her world (Freeman and Jessup 2004). Systems that expose individuals to a larger number of their colleagues' world-views (e.g., Majchrzak et al. 2004) may enhance the transfer of novel information. For any given level of bookmarks accessed, an employee who has tapped into a larger number of different world-views is thus more likely to discover novel information.

*H2: The number of people an individual connects to by accessing their social bookmarks will positively predict his/her level of personal innovativeness.*

### **Social Diversity**

A core principle in the social networks literature is that individuals are more likely to access novel information when they connect to people who are themselves not connected to one another (Burt 2005). Two enduring principles of social structure help clarify why this is likely to be true. First, people tend to associate with others with whom they share some degree of similarity (McPherson et al. 2001). Second, ongoing interactions among people within a group tend, over time, to reduce the variation in their knowledge and behavior (Kilduff and Tsai 2003). Burt (1992, 2004) describes the gap between groups or individuals who are not connected as *structural holes*; people who are separated from each other in this way are more likely to possess dissimilar information (e.g., Burt 1992; Granovetter 1973; Simmel 1955). Organizations are often rife with such structural holes, which creates an opportunity for those who can connect across them and act on the information so obtained (Brass 1984; Burt 1992; Hargadon and Sutton 1997; Reagans and Zuckerman 2001).

Connecting to others across a structural hole "puts people in a position to learn about things they didn't know they didn't

know" (Burt 2005, p. 59). The specific causal processes involved are based on dyadic interactions between individuals who selectively share important information (e.g., Burt 1992, pp. 13-15). The value of such a relationship is amplified when it spans a structural hole because the likelihood of obtaining unique information is higher when the parties involved share no other mutual contacts (Csikszentmihalyi and Sawyer 1995). This puts employees in a position to observe, evaluate, and import unique ideas (DiMaggio 1992), provides them with a broader range of perspectives on the challenges they face, and enables them to take different kinds of actions (e.g., Ancona and Caldwell 1992; von Hippel 1988). Employees who have access to unique information by spanning structural holes are, therefore, likely to be more innovative in their behaviors (Burt 2004).

Hargadon (2002) takes a microsociological approach to understanding how innovative ideas and actions are shaped by individuals' social structures, arguing that many innovative outcomes can be explained as the movement of ideas "from where they are known to where they are not" (p. 41). Although other researchers also see innovation as the recombination of existing ideas (e.g., Henderson and Clark 1990; Weick 1979), Hargadon emphasizes the inherent fragmentation of social structures as the source of many innovation opportunities for those who can broker across unconnected groups. His research (e.g., Hargadon 1998; Hargadon and Sutton 1997) establishes the notion that much of what may appear to outsiders to be invention is actually best explained as the recombination of ideas taken from different and unconnected contexts.<sup>3</sup> The diversity in ideas and information that is present in many organizations sets the stage for those individuals who can bridge across silos and recognize new possibilities, and as a result appear to their colleagues to be more creative and innovative.

Although this idea has considerable intuitive appeal, structural holes theory must be re-conceptualized in order to operate in a social bookmarking environment, where two underlying assumptions of interpersonal network theories do not hold. First, research on interpersonal networks theorizes relational ties between individuals based on dyadic interactions that create a social bond (Kilduff and Tsai 2003). No such two-way interactions are possible via contemporary social bookmarking systems; indeed, when an individual accesses another person's bookmarks, this action cannot be noticed by that

<sup>3</sup>Though others have sought to describe the optimal conditions for information brokering as occurring between individuals who have "weak ties" (Granovetter 1973), the underlying argument is really about fragmented social domains, with Granovetter taking tie strength as a proxy for social distance.

other person. Second, research on networks and innovation theorizes that individuals often selectively release information to some others, but not to all (Burt 2005). Social bookmarking systems do not provide this kind of limited information release, as all users have access to the same bookmarks.

To explain social bookmarking systems from a structural holes perspective, therefore, requires a reconceptualization of the underlying theoretical processes in order to account for a technology that offers undifferentiated information access via a one-way channel that is open to all who care to look. Fundamentally, the information individuals obtain via such systems will only make them appear more innovative if their coworkers do not also have the same information. But because social bookmarking systems do not allow information providers to be selective in what information they provide to whom, hole-spanning informational benefits are only possible if information seekers are selective in what they obtain. If this is true, then diversity in information seeking behavior across employees can produce the underlying conditions necessary for structural holes to appear, and for individuals to obtain novel information that can enhance their innovativeness.

A variety of research suggests that individuals often sub-optimize in their information searches—for instance, when they seek to conserve attention (Davenport and Beck 2001; Hansen and Haas 2001), terminate their information searches prematurely (Prabha et al. 2007), and consider only information sources that are locally relevant (Choo 1998) and easily accessible (Leckie et al. 1996). Significant heterogeneity in information seeking is thus likely across the organization (Kim and Allen 2002), driven by a range of factors including position (e.g., Daniels et al. 2002), work demands (Vandebosch and Higgins 1996), personal characteristics (Schneider and Shiffrin 1977), and aspects of idiosyncratic experiences (Dervin and Nilan 1986). Heterogeneity in information seeking is similarly likely in a social bookmarking context, and can, therefore, take the place of the theoretical processes surrounding selectivity in information provision originally proposed in structural holes theory. While social bookmarking in principle may make the same information available to all, different individuals are likely to access different bookmarks and, as a result, discover unique combinations of information sources.

Heterogeneity in information seeking thus creates the possibility that structural holes can exist in the network of connections that is created as individuals access each other's bookmarks. We therefore hypothesize that the likelihood of discovering novel information is a function of the extent to which the people whose bookmarks one accesses are them-

selves not connected—known in the literature as the *effective size* of their network. At one extreme, an individual may access bookmarks made by a set of people who all happen to have accessed each other's bookmarks; such a set of individuals are operating in a somewhat constrained topical space (Marlow et al. 2006), are likely to share similar interests, and are likely to draw information from similar sets of digital resources. An individual who accesses many bookmarks made by such an interconnected group is, therefore, more likely to obtain redundant information with each subsequent bookmark accessed. In contrast, an individual may obtain much more novel information if he/she accesses bookmarks that are made by a set of people who do not access each other's bookmarks. Such people would be more likely to have diverse world views and dissimilar interests, and would be less likely to bookmark similar sets of digital resources. Accessing their bookmarks is thus more likely to reveal novel information, leading an individual to have higher levels of personal innovativeness.

*H3: The extent to which the people an individual connects to by accessing their social bookmarks are not themselves connected through the bookmarking system will positively predict that individual's level of personal innovativeness.*

Our final hypothesis considers the extent to which the people whose bookmarks an individual has accessed are each in turn making extensive use of the bookmarking system to discover novel information resources. Following Hanneman and Riddle (2005), we use the term *effective reach* to describe the extent to which an individual's direct contacts are linked to many other nonredundant contacts. In a social bookmarking system context, an individual's network will have higher effective reach when he/she accesses the bookmarks of people who are themselves more frequently accessing the bookmarks of individuals who are not connected. The mechanism by which such a second order network would operate builds on the way in which we have theorized first order effects: If person B accesses many bookmarks of people who do not themselves access each other's bookmarks, then person B is likely to be exposed to more novel ideas. When person B keeps track of some of those novel ideas by bookmarking them himself/herself (or pursues those ideas and finds other supporting resources which he/she bookmarks), and when person A accesses those bookmarks, novel information may be passed on to person A. An individual who accesses the bookmarks of people who themselves have foraged broadly for information resources via the social bookmarking system is, therefore, more likely to discover novel information, and is, in turn, more likely to get innovative ideas. In contrast, if an individual accesses bookmarks made by a set of people

whose networks of connections through the bookmarking system have small effective sizes, then his/her access to novel information via the bookmarking system will be more limited.

*H4: The extent to which the network of people an individual connects to by accessing their social bookmarks provides indirect access to many nonredundant bookmarks will positively predict his/her level of personal innovativeness.*

## Research Method

To test our research model, we approached a global professional services organization that creates, implements, and supports technology-based initiatives to help clients with complex business problems. The firm employs approximately 5,000 consultants, scientists, and engineers in a handful of major business units based in several U.S. and international sites. Work is accomplished mainly through distributed work teams, and employees often work on multiple project teams simultaneously. Clients look to the firm for thought leadership across a range of knowledge domains, which means that employees must rapidly acquire and assimilate new information and knowledge. The firm has historically been a leader in the use of technologies to speed the internal flow of information. In the 1990s, the firm began using electronic mailing lists and document repositories to share information. Starting in 2000, the firm began to deploy social collaboration tools. An internal social bookmarking application, based on the popular Internet social bookmarking service del.icio.us, was rolled out several years prior to our research to help employees keep track of their bookmarks and tag them with keywords for easy search and retrieval. Adoption of the bookmarking tool grew rapidly, with over 50,000 bookmarks made after 2 years. Employees primarily used it to bookmark publicly available resources, with the ratio of bookmarks and tags made to resources on the public internet versus those made to resources only available on the internal company intranet being approximately 5:1. Some examples of common types of tags used to categorize bookmarks include

- Specific vendor applications (sample tags: Microsoft, Google, Java, opensource)
- Information format (sample tags: blog, wiki, rss, video)
- Type of functionality discussed (sample tags: security, collaboration, visualization)
- Company-specific white papers (sample tags: research, reference, [company name])

### Bookmarking System Use: A Success Story

An example of how the use of a social bookmarking system enhanced the innovativeness of one respondent's work: "I started using [the internal social bookmarking application] when I needed to give a presentation the following day. My new project involved the visual representation of data, and I did a quick search using the 'visualization' tag to see what was out there. The search results provided me with a number of visualization-related tagged resources and names of people working in this area. So, I was able to find relevant content and use it to develop my own ideas for the presentation, which went over very well. Since then, I use [the system] at least several times a week to help me keep up-to-date with the visualization area. I've been [accessing the bookmarks of] a few select colleagues, who I didn't know before, who are experts in this area. They've written white papers, presented at conferences, and answered questions regarding visualization; [their bookmarks and] tags have triggered ideas that I never would have thought to research and potentially use. There are so many subfields in visualization that I've now been exposed to a lot of different applications and uses of this technology. The end result is that I've gained a wide breadth of knowledge in this particular domain in a short amount of time, and customers and peers have responded very positively when I present these creative ideas at review sessions."

### Sample and Data Collection

When collecting data on our dependent variable, we were asked by managers to survey only a subsample of the population of 850 bookmarking system users. To ensure that our data contained sufficient variation, we calculated the total number of bookmarks accessed by each user and selected a random subset of 150 stratified across high, medium, and low usage levels.

Our dependent variable was an assessment of each user's level of personal innovativeness as reported by external evaluators who could more objectively assess innovative behaviors (Shalley et al. 2004). A commonly used scale was developed by Scott and Bruce (1994), based on Kanter's (1988) process model of organizational innovation, which has been adapted and used in a variety of research (e.g., Changa and Liub 2008; Choi 2007; Ganesan and Weitz 1996). To ensure that items would be maximally relevant to our context, we adapted two items from this scale that measured the gener-

ation and promotion of ideas:<sup>4</sup> “This person generates creative work-related ideas,” and “This person promotes and champions work-related ideas to others.” In discussions with a range of firm managers, we found universal agreement that these two behaviors could effectively distinguish between more and less innovative employees.

We asked each subject to provide one or two names of individuals within the organization who were in a position to evaluate their level of personal innovativeness. We assured all parties complete confidentiality; no one (including the respondent) would be able to view these innovativeness assessment results. Endogeneity was not a concern in using evaluators for two reasons: (1) evaluators were not informed that their evaluations would be tied to individuals’ social bookmarking system use, and (2) bookmark-accessing behaviors were not visible to any outside evaluators. As a result, we had no reason to expect that our dependent variable was confounded with our independent variables. Of the full set of 150 subjects, 120 (80 percent) provided evaluator names. We sent a short e-mail survey to these evaluators, asking them to rate the subject using the two items listed above using six-point Likert scales anchored on “strongly disagree” (1) and “strongly agree” (6), and to return their responses directly to the research team. All (100 percent) of the assessment surveys were completed. Reliability across the two measurement items was 0.95. Ninety percent of respondents provided two evaluators names, and we found strong inter-rater reliability ( $r = 0.92$ ) between pairs of evaluators. Despite the potential for bias because respondents voluntarily provided the names of evaluators, we saw considerable variance in responses (scores ranged from 1 to 6, mean 4.26, standard deviation 1.74). We averaged responses when more than one evaluator provided ratings on a single individual.

We calculated scores for each independent variable from our archival data using the full set of 850 bookmarking system users, first splitting our dataset into year1 and year2 data (year1 began a few weeks after system launch). Because information often diffuses through a population over time, individuals who seek to benefit from novel information are likely to act on it when it is still novel. Consequently, innovativeness is likely to be enhanced close in time to when a bookmark was accessed; bookmarks that were accessed in year1 are unlikely to affect an individual’s level of innovation at the end of year2. Since our hypotheses posit associations

<sup>4</sup>We did not use items from the original scale that focused on implementation (e.g., securing funding and developing schedules for idea implementation), as the majority of employees in the firm were not responsible for implementation-related activities.

between bookmark access and innovativeness, we tested our models using year2 data—the 12 months immediately prior to when we collected data on personal innovativeness. However, as described at the end of this section, we also conducted a *post hoc* test using year1 data in order to demonstrate that exogenous factors such as personality characteristics were unlikely to provide an alternate explanation for our findings.

To test our hypotheses, we used archival data on whether each subject accessed the bookmarks of each of the 850 users. To test H1, we calculated each subject’s bookmarking system use by totaling the number of times he/she accessed others’ bookmarks<sup>5</sup> in the year2 data.

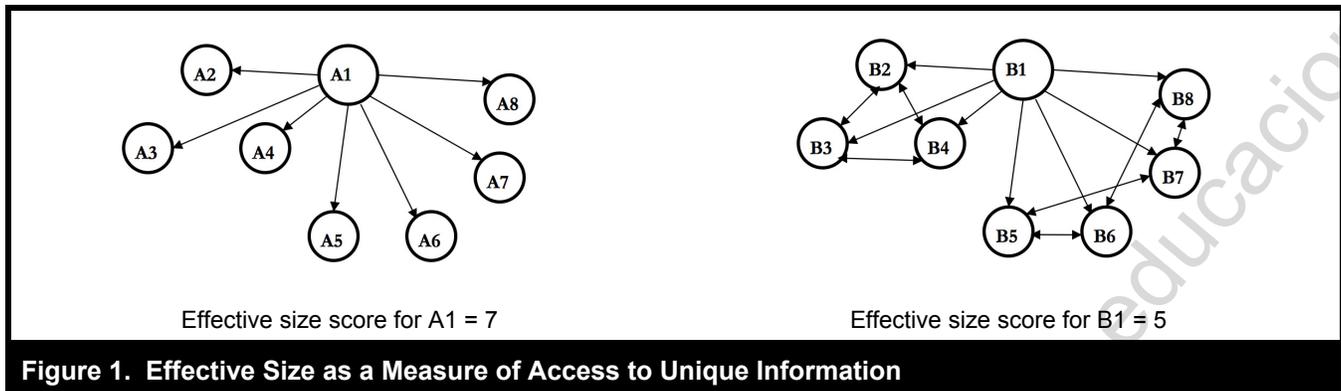
To test H2, H3, and H4, we used UCINET 6 software (Borgatti et al. 2002) to analyze the dichotomized directional network of bookmark access connections, with each cell coded a “1” if an employee had accessed at least one bookmark made by another individual, and a “0” otherwise. We computed three network characteristics, described in detail below, and used them in a regression analysis to test our last three hypotheses.<sup>6</sup>

To test H2, we computed *outdegree centrality* (Freeman 1979): for a given person (called “ego”), outdegree centrality is the total number of people (called “alters”) to which ego directly connects. In our bookmarking system context, outdegree is a measure of the number of different alters whose bookmarks each ego accessed, which indicates how broadly each ego foraged for information (ranging from 1 to 100 alters, with a mean of 24.30).

To test H3, we computed network *effective size* (Burt 1992), which reflects the extent to which ego spans structural holes by connecting to alters who are themselves not connected. Since alters who are connected are more likely to provide redundant information, effective size reflects the extent to which ego’s network is likely to yield nonredundant information (Burt 1992). The effective size for a given ego is

<sup>5</sup>We also asked subjects to self-report the frequency with which they used the social bookmarking system, and found the result to be highly correlated with the sum of bookmarks accessed ( $r = 0.89$ ). While there may be superior ways of estimating information novelty by examining features of the actual content obtained through a social bookmarking system, our feature-use-level data did not allow us to measure more specific indicators of information novelty such as document uniqueness, length, age, overlap, etc.

<sup>6</sup>We checked the skewness and kurtosis of all variables and found them to be within acceptable limits and so we proceeded without any transformations. An assessment of residuals indicated that regression results were not driven by outliers.



**Figure 1. Effective Size as a Measure of Access to Unique Information**

defined as the number of direct ties ego has to alters, minus the average number of ties that each alter has to other alters (e.g., Heng et al. 2005; Taylor and Doerfel 2003). In our data, effective sizes ranged from 1 to 60.1, with a mean of 11.39. Figure 1 illustrates how differing effective sizes are possible even when two egos have the same outdegree. The effective size of A1's network is seven, as none of A1's alters are connected to one another, which makes it less likely that they will provide redundant information. Because each of B1's alters has two ties to other alters, the effective size of B1's network is  $(7) - (2) = 5$ , reflecting the likelihood that some alters may provide redundant information.

To test H4, we computed *effective reach*, which reflects the extent to which ego is indirectly tied to nonredundant alters. Effective reach provides an index of the size of the bookmark access network that extends beyond ego's direct contacts, while controlling for redundant ties. In the context of social bookmarking systems, an effective reach score is high (1) for egos who have accessed the bookmarks of many unconnected alters, and (2) when those alters have each in turn accessed the bookmarks of many unconnected others. We calculated this coefficient by combining the distance measure (Burt 1976; Doreian 1974) and the effective size measure (Burt 1992) in UCINET 6. In our data, effective reach scores ranged from 1 to 90, with a mean of 22.09. Figure 2 illustrates how the effective reach score is calculated. A1 has direct access to two individuals (A2 and A3), indirect access to four individuals (A4, A5, A6, and A7) who are two degrees removed, and indirect access to three individuals (A8, A9, and A10) who are three degrees removed. The bookmarks that A1 accesses may, therefore, reflect a broader range of information, including information obtained by A2 and A3 in their own social bookmarking system use. The geodesic distance measure provides the optimum (or shortest) path length among nodes in our network, and this is how the second-degree, third-degree, etc., network for each node is determined. We calculated the effective size of the first-degree network, the second-degree network, the third-degree

network, etc., in the same manner as described previously. Mathematically, our effective reach metric "discounts" nodes that are two degrees away from the ego (by a factor of one-half), three degrees away from the ego (by a factor of one-third), etc. (Borgatti et al. 2002; Hanneman and Riddle 2005). Therefore, the effective reach score for A1 is the summation of the effective scores for the first-degree network (two), the second-degree network (one, after discounting by one-half), and the third-degree network (one, after discounting by one-third), for a final score of four.

We also included dummy variables for several controls in our model: tenure (fewer than 5 years, between 5 and 15 years, more than 15 years with the firm), job level (using human resources data on skill requirements), location (main site 1, main site 2, other location), and division (see Table 1).

## Results

We used a series of ordinary least squares regression equations to test our hypotheses (see Table 2).<sup>7</sup> Model 1 tested only the control variables, with no significant effects on personal innovativeness. Model 2 included the measure of total bookmarks accessed, which was not significant (H1,  $\beta = 0.13$ , n.s.). Model 3 added the outdegree centrality measure, again with no impact (H2,  $\beta = 0.16$ , n.s.). Model 4 added the effective size coefficient, which did have a significant effect on personal innovativeness (H3,  $\beta = 0.48$ ,  $p < .01$ ). Finally, Model 5 tested all hypothesized predictors, with effective reach significantly influencing the dependent variable (H4,  $\beta = 0.46$ ,  $p < .01$ ). Although coefficients changed as new variables were added to each model, no effects that were significant became nonsignificant as a result, or vice versa. In total our final model explained 39 percent of the variation in personal innovativeness.

<sup>7</sup>All VIF scores are less than 2.5, suggesting that multicollinearity was not a problem (Neter et al. 1990).

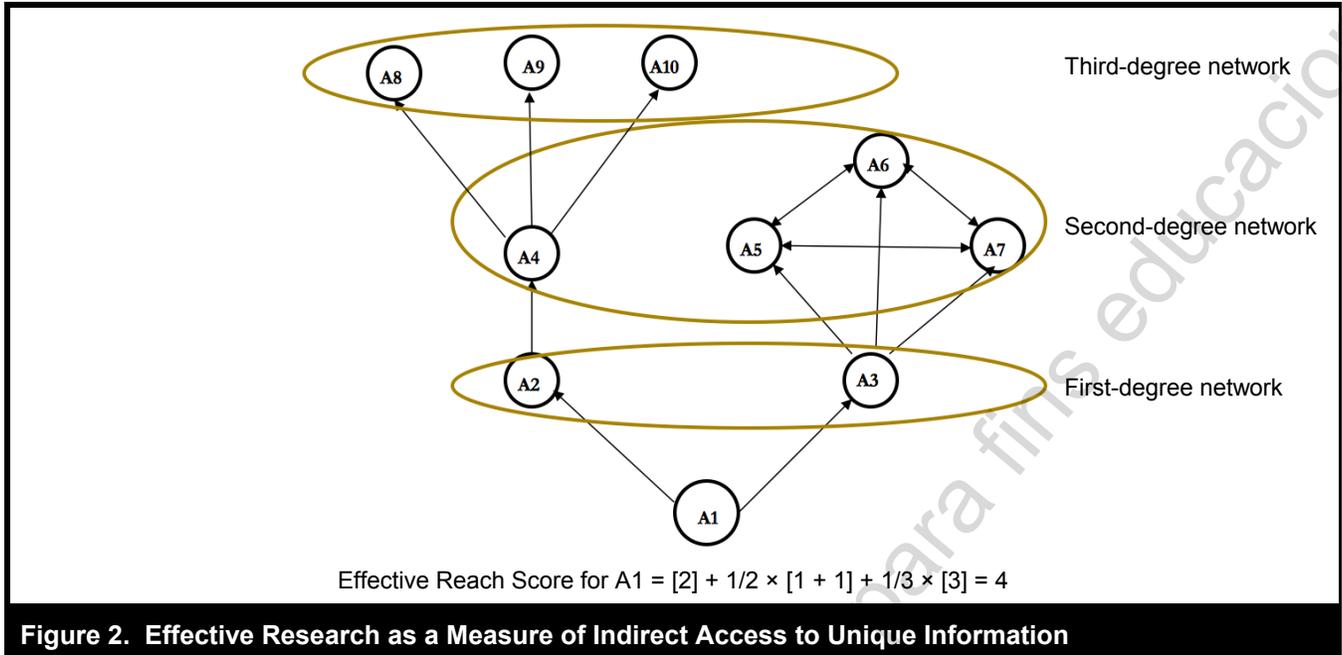


Figure 2. Effective Research as a Measure of Indirect Access to Unique Information

Table 1. Means and Correlations

Variables	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12
1. Tenure	2.09	.79												
2. Job Level	4.47	1.17	.46**											
3. Location 1	.38	.49	-.11	-.02										
4. Location 2	.48	.50	.12	-.02	-.75**									
5. Division 1	.27	.44	-.07	-.12	-.08	.02								
6. Division 2	.24	.43	-.07	.10	-.08	.04	-.34**							
7. Division 3	.18	.38	.11	.11	.10	-.18*	-.28**	-.26**						
8. Division 4	.15	.36	.04	-.09	-.04	.15†	-.25**	-.24**	-.19*					
9. Bookmarks Accessed	85.2	92.1	-.15†	-.09	-.05	.14	-.12	-.09	-.14	.05				
10. Out Centrality	24.3	30.5	-.10	.03	.13	-.05	.18†	-.07	.09	-.10	-.02			
11. Effective Size	11.4	16.2	-.12	.07	.07	.04	.17†	.02	-.10	-.08	.06	.60**		
12. Effective Reach	22.1	22.8	.02	.09	.05	-.02	.08	.04	-.14	.10	.02	.15	.32**	
13. Innovativeness	4.26	1.74	.10	.10	.06	-.03	-.02	-.07	-.07	.07	.13	.13	.38**	.54**

n = 120; †p < .1; \*p < .05; \*\*p < .01

**Table 2. Standardized Results of Regression Analysis Predicting Innovativeness**

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant (y-intercept)	3.58	3.14	3.17	3.30	3.17
Company Tenure	.06	.08	.11	.15	.13
Job Level	.10	.10	.08	.02	-.01
Location 1	.07	.07	.02	-.02	-.03
Location 2	.00	-.02	-.05	-.10	-.07
Division 1	-.09	-.03	-.08	-.11	-.17
Division 2	-.14	-.08	-.10	-.12	-.17
Division 3	-.15	-.10	-.14	-.09	-.08
Division 4	.00	.03	.02	.04	-.06
<b>H1. Bookmarks Accessed</b>		<b>.13</b>	<b>.12</b>	<b>.10</b>	<b>.08</b>
<b>H2. Outdegree Centrality</b>			<b>.16</b>	<b>-.12</b>	<b>-.09</b>
<b>H3. Effective Size</b>				<b>.48**</b>	<b>.32**</b>
<b>H4. Effective Reach</b>					<b>.46**</b>
<b>R<sup>2</sup></b>	<b>.04</b>	<b>.05</b>	<b>.08</b>	<b>.21</b>	<b>.39</b>
Standard Error of the Estimate	1.77	1.76	1.75	1.62	1.43
F	.59	.70	.91	2.65**	5.78**

Values represent standardized coefficients (except for Constant)

n = 120; †p < .1; \*p < .05; \*\* p < .01

### Post Hoc Test

Information that is novel to an individual's context is likely to become less novel over time as others also discover it and dilute its relative uniqueness. Because it is likely to be more broadly known, information obtained two years ago is less likely to influence an individual's innovativeness than information obtained last month. Further, individuals who obtain novel information are likely to act on it promptly, while it still has the ability to differentiate them to their peers; thus, none of the hypothesized relationships should appear as strongly between the data on bookmark accessing in year1 and our dependent variable. We repeated our regression analyses using the year1 data and found no support for any of our hypothesized predictors, bookmarks accessed ( $\beta = 0.10$ , n.s.), outdegree ( $\beta = 0.10$ , n.s.), effective size ( $\beta = 0.15$ , n.s.), or effective reach ( $\beta = 0.15$ , n.s.). Novel information obtained through social bookmarks enhances employees' innovativeness close in time to when they obtain it, and not years later.

Implicit in this *post hoc* test is a *ceteris paribus* assumption, most importantly that the underlying nature of the networks we studied did not change in significant ways between year1 and year2. On key metrics, the year1 and year2 networks

were indeed very similar—for instance, in terms of outdegree centralization (22.1 percent versus 23.0 percent) and number of people viewing tags (500 versus 477). This lends confidence to our interpretation of the year1 results, namely that the effects reported in Table 2 were not merely a product of an unmeasured individual trait that affected both bookmarking system use and innovativeness. Had our results been a product of individual characteristics (e.g., disposition or personality) that covary with both personal innovativeness and bookmarking system use, then the results would have held for the year1 data and the year2 data. But this was not the case. The fact that there are no significant effects in the year1 data suggests that unmeasured individual characteristics are not causing spurious correlations that could be confounding our results.

### Discussion

Social bookmarking systems help bring social navigation to the enterprise. They direct attention to those digital resources that are more likely to be relevant and interesting to an organization, both by letting employees search on tags to see

what others have bookmarked, and by letting them examine colleagues' bookmark collections to see what they have been reading lately. By doing this in a way that is unobtrusive and that has no incremental cost to the person who created a bookmark, such systems can succeed where other approaches to sharing ideas might be significantly more difficult and time consuming, and subject to forgetting and various recall biases. Our research brings social bookmarking squarely into the realm of social network theory and shows how it can benefit organizations by enhancing employee innovativeness.

A key theoretical pivot was necessary in order to explain bookmarking from a structural holes perspective. Social bookmarking systems are not simply substitutes for interpersonal social networks; they cannot provide the rich two-way interactivity that is possible via interpersonal networks. We theorized that structural holes in the bookmark access network could explain innovativeness even when the technology prevented employees from being selective in whom they would provide information. Our results confirm that structural holes theory does hold, with selective information seeking a viable explanation for why structural holes exist when the same bookmarks are available for all to see. Providing individuals with the ability to selectively and unobtrusively peek over others' shoulders to see what they were reading influenced personal innovativeness when the bookmarks they accessed were more likely to contain novel information. Network-level concepts, therefore, seem to provide an appropriate level of analysis when attempting to understand the benefits of social bookmarking systems. Analysis at the network level is less broad than general measures of use, but more meaningful than treating each information resource individually. Indeed, had our research focused only on traditional use metrics, we might have concluded that social bookmarking systems offered no benefit to organizations. In the language of Burton-Jones and Straub (2006), we have shown that richer system use metrics can produce more insightful results than lean use metrics. By showing how the use of an under-theorized technology could result in the kind of movement of ideas across social contexts theorized by Hargadon (2002), our results contribute to the small but growing literature that seeks to understand IS usage through a network lens (e.g., Butler 2001; Kane and Alavi 2008; Robert et al. 2008; Schultze and Orlikowski 2004).

Our results also may have implications for the social networks literature. We question the dominant perspective voiced in the structural holes literature, which hinges on selectivity in information provision from alters as key to why some egos are more innovative than others. Burt's (1992) theoretical mechanisms are premised on the idea that alters are only

willing to selectively help egos they know. But the idea that structural holes might be explained by egos' selectivity with regard to which alters they approach for information is rarely considered. Because the bookmark access data we employed is directional (each is a one-way connection), our results can only be explained by selectivity in information seeking. This suggests that perhaps some of what has been seen in the structural holes literature as selectivity in alters' information provision is in fact selectivity in egos' information seeking behaviors. Given the general difficulty of separating these two effects in interpersonal social networks, our use of archival data from a bookmarking system introduces a level of precision in understanding directionality that is typically not possible. Social network research may, therefore, benefit from this evidence as a catalyst for more precisely theorizing and testing a variety of ways in which structural holes could be created. However, our research suggests that structural holes remain a very relevant explanation of innovativeness even in contexts not directly contemplated by the originator of structural holes theory.

The pattern of significant findings that emerged in our results suggests that, when theorizing individual-level innovativeness, sheer amount of information seeking may be a less important concept than the social diversity of information sources. The two primarily quantity-driven metrics of information seeking we employed did not significantly impact our dependent variable, but the two metrics that incorporated connections amongst alters did. The underlying message is one that has intuitive appeal: whom one turns to for information matters more than the simple amount of information one accesses. The implications of being able to theorize and test these competing ideas in a social bookmarking system context are surely exciting for a field that appreciates the importance of bringing strong theory to bear on new types of technologies. While our results do not automatically generalize, research into other Web 2.0 technologies may benefit from a similar approach; for example, similar causal processes may explain how employees' choices of which blogs to read influences their personal innovativeness. However, as security and access control features in social technologies continue to evolve over time, it is likely that both selective information provision and selective information seeking will together influence the relative novelty of information that can be found using Web 2.0 tools.

Our results are also important for IT managers who must make informed decisions about whether these technologies are worth supporting. Being able to demonstrate that social bookmarking system use can enhance personal innovativeness is a major milestone for Web 2.0 research, which to date has

lacked empirical studies that point to the organizational value of such systems. IT managers who are keen to find success stories that they can use to promote adoption of a bookmarking system may, therefore, look for anecdotes that connect information found in the system to important innovation outcomes. Indeed, for those organizations that already have bookmarking systems in place, our results could be used to discover such success stories by identifying those users who are most likely to have brokered information obtained through the bookmarking system, and who have used that information to be more innovative in the workplace. Finally, it may also be useful for managers to employ social network analysis tools to analyze bookmarking system data in order to produce two kinds of recommendations. First, network analysis could be used to identify those users who have dense and redundant bookmark access networks; such users would be prime candidates for training or mentoring to encourage them to reach out more broadly and tap into a wider range of perspectives in order to enhance their innovativeness. Second, software could be developed to analyze each individual's bookmark access network and produce suggestions as to bookmarks that he/she could access that would be most likely to reflect divergent perspectives (that is, bookmarks that had been accessed by few or none in his/her existing network or group of colleagues). While this latter approach could never be sure to identify highly relevant bookmarks (indeed, many could be entirely irrelevant), our research suggests that regular use of such a feature could expose individuals to perspectives and information that is quite different from what they typically view, which could in turn lead to higher levels of innovativeness. While the benefits of such a system of personalized bookmark recommendations would surely need to be offset against the time invested in regularly accessing bookmarks that might be of questionable relevance, such a tradeoff might be worth making for organizations (or select units of organizations) that truly value innovation.

### Limitations

Several limitations may bound the broad applicability of this research. First, the types of employees we studied might not be representative of the broader population of employees. Second, the effects we found might not be present in organizations that have fewer information silos than do consultancies. Third, since our study was not designed to capture the characteristics of the social system within which the employees were embedded, there are many questions that we cannot answer, including the roles individuals had in the broader social structure, individuals' motivations to make their bookmarks public, whether individuals' reputations

attracted others to access their bookmarks, and the social benefits that accrued to those who created bookmarks. Our efforts to explain bookmarking must, therefore, be tempered by a realization that other mechanisms beyond what we were able to uncover may also be important in explaining social bookmarking. Fourth, our relatively lean two-item measure of innovativeness focused on generating, promoting, and championing new ideas, and, as such, may not fully capture the full set of behaviors that would reflect a rich conceptualization of innovation at the individual and/or organizational level. Fifth, it is possible that causality does not flow in the direction we hypothesized, from accessing bookmarks to innovative outcomes. However, given that our data measure behaviors that occurred prior to the point at which we measured personal innovativeness, it seems unlikely that the latter would influence the former.

A final caveat on our work is that we progressed based on the assumption that greater innovation is desirable, and that companies in general would benefit from more innovation. However, it is possible that some companies might benefit from *less* innovation; if a company generated too many ideas and failed to execute on them, perhaps balancing innovation with better execution would be a more important priority. Our present work does not help managers understand how social bookmarking systems might help address such a challenge, although future work might well build on ours to relate bookmarking system use to multiple outcomes.

### Conclusion

A social network approach to understanding how social bookmarking systems help individuals bridge structural holes to access novel information helps explain why some employees are more innovative than others. Our research suggests that social bookmarking systems may help lubricate the movement of ideas across social contexts as theorized by Hargadon (2002), and thus offers an exciting bridge between the IS literature and the organizational innovation literature. We hope that this research will inspire more investigations into the social network effects of other social technologies, and so build a cumulative body of evidence about their value to organizations.

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### About the Authors

**Peter Gray** is an associate professor at the McIntire School of Commerce, University of Virginia. His research focuses on the collaborative impacts of social technologies, organizational networks, virtual teams, online communities, and knowledge management systems. His research has been published in a range of leading journals, including *MIS Quarterly*, *Information Systems Research*, *Management Science*, *Sloan Management Review*, *Organizational Research Methods*, *Journal of Management Information Systems*, *Journal of Strategic Information Systems*, *Information Technology & People*. He holds a Ph.D. from Queen's University in Kingston, Canada.

**Salvatore Parise** is an associate professor in the Technology, Operations, and Information Management Division at Babson College. His research focus is in the areas of social networks, social media applications, knowledge management and human resource development practices, strategic alliances, and management pedagogical research. His research has been published in several leading academic and management journals including *Journal of Organizational Behavior*, *MIT Sloan Management Review*, *California Management Review*, *Journal of Management Education*, and *IBM Systems Journal*. He received his Doctorate of Business Administration from Boston University.

**Bala Iyer** is an associate professor in the Technology, Operations, and Information Management Division at Babson College. He also holds the William D. Bygrave Term Chair in Technology. Bala received his Ph.D. in Information Systems from New York University with a minor in computer science. His research interests include exploring the role of IT architectures in delivering business capabilities, designing knowledge management systems using concepts from systems design, hypermedia design and workflow management, querying complex dynamic systems, and model management systems. For the past several years, he has been analyzing the software industry ecosystem to understand the logic and patterns of emergence of architecture and platforms.

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