Competing for Attention in Knowledge Markets: Electronic Document Dissemination in a Management Consulting Company

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The relatively recent explosion of information available in electronic forms makes attention, rather than information, the scarce resource in organizations. In this paper, we theorize about how suppliers of electronic information compete for this resource and use data on document database use in a management consulting company to show that document suppliers that occupied a crowded segment of the firm's internal knowledge market gained less attention from employees (measured as monthly use of their database) but were able to combat this negative competitive effect by being selective and concentrated in their document supply. This result reveals a paradox of information supply in competitive information markets: the less information a supplier offered, the more it was used, because the supplier developed a reputation for quality and focus. We suggest that this view of competition for attention can also be applied to the competition among Web sites in external information markets.●

> Five years ago, business unit people complained that they did not get enough information from us. Today they complain that they're drowning in information.
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> —Corporate manager, Hewlett-Packard[1]

An emerging phenomenon in contemporary society and organizations is the large and increasing supply of readily available information in electronic forms. Studies have shown that the average *Fortune* 1000 worker receives more than 50 e-mail messages a day (Pitney Bowes, 1997) and that the amount of corporate data stored on computers is doubling every 12 to 14 months (Bank, 1997). This large and increasing supply of electronic information creates processing problems for individuals. For example, of 1000 employees surveyed, 61 percent reported that they were confronted with too much information relative to the needs of their job (Reuters, 1998). A study of 500 physicians reported a similar finding (Hunt and Newman, 1997).

In information-rich contexts that are characterized by a large supply of information available in electronic forms, the scarce resource is typically not information, but the amount of attention that individuals can allocate to searching for, sorting through, and interpreting the available information (Ocasio, 1997). As Simon (1997: 40) argued, "a wealth of information creates a poverty of attention." Yet much of the existing research on information dissemination in organizations is premised on the view that information is scarce and difficult to obtain. The central problems for individuals were, therefore, to enhance the flow of information through cross-unit linkages (e.g., Galbraith, 1973; Tushman, 1977), search for knowledge not immediately available (e.g., Hansen, 1999), transfer complex knowledge (e.g., Zander and Kogut, 1995), and reduce message distortions during transmissions (Shannon and Weaver, 1949). Although this prior emphasis has been appropriate in contexts with a dearth of distributed information (Pfeffer, 1994), it is less helpful in information-rich contexts, where organization members are likely to experience information overload (i.e., a very high ratio of readily available information to the information needed to complete a task) and confront much information that is irrelevant for their

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1
Interview with first author, 1997.

tasks (Huber and Daft, 1987; Sproull and Kiesler, 1991; Whittaker and Sidner, 1997) but do not have a sufficient amount of attention to sort through all of it (Cyert and March, 1992). Because attention is a scarce resource in an information-rich organization, organization subunits that wish to disseminate their information are likely to compete for this scarce resource. In this paper, we focus on how suppliers of electronic documents compete among one another to gain the attention of users in organizations that are characterized by a large supply of this type of knowledge and where there is, therefore, an internal market for knowledge.[2]

COMPETING FOR ATTENTION IN AN INTERNAL KNOWLEDGE MARKET

We conceive of electronic document dissemination in an organization as an internal knowledge market, much like scholars have described internal markets for labor and capital (e.g., Althauser, 1989; Stein, 1997). We make four assumptions about such a market (cf. Polanyi, 1944: 56). We first assume that there is a distinct set of users of electronic documents. Employees may search the organization's internal databases for electronic documents to help them complete their tasks. Although these searches may involve other sources of information, such as personal contacts that may contain richer forms of knowledge (Daft and Lengel, 1984; Hansen, 1999), we limit our discussion to electronic documents. We further assume that there is a distinct set of suppliers of electronic documents, such as practice groups or marketing departments. These individuals or subunits are responsible for gathering, selecting, editing, codifying, and publishing codified knowledge in the form of electronic documents and making them available to employees via databases.

We also assume that both document suppliers and document users receive rewards for their participation in the internal knowledge market and that these rewards create incentives for supplying and using knowledge. Electronic document suppliers may receive direct rewards through regular performance evaluations or social rewards such as status and respect in return for providing useful documents (cf. Blau, 1964). Employees are likely to be motivated to use electronic documents to the extent that such documents help them to perform their tasks. Their use of documents may also be assessed in formal performance evaluations.

Our fourth assumption is that there is a nontrivial matching problem between the dispersed sets of users and suppliers of documents. Because there is likely to be some ambiguity about the quality and relevance of the large quantity of documents available electronically, users cannot easily identify appropriate documents, leading to difficulties in matching documents and users (cf. March and Olsen, 1976; Podolny, 1994). One way to mitigate this problem is to install sophisticated search engines to help users precisely identify those documents that are likely to be most helpful. But in the absence of near-perfect search engines, users are likely to experience problems in finding relevant documents.

2
Because such electronic documents can contain information and knowledge, we do not make a sharp distinction between these terms and use them interchangeably. For example, electronic documents may include data (e.g., market numbers), information (e.g., a market analysis), and more complex forms of knowledge (e.g., know-how about how to enter markets).

User Search and Supplier Market Positions

User search. Problems of finding relevant electronic documents in an information-rich organization can be solved if users allocate enough attention to the task of sorting through large quantities of information, but there are likely to be limits on the extent to which individuals can attend to this search task (Cyert and March, 1992). An important constraint on disseminating electronic documents is therefore the availability of users' attention, which we define as the amount of time and energy that employees in an organization allocate to identifying, evaluating, and acquiring documents from electronic information sources in the organization (Simon, 1997).

Rather than conducting exhaustive searches, users with limited attention are likely to engage in sequential searches, beginning with one or a few document sources, then proceeding to consult additional sources until they find a sufficient number of useful documents or establish that they cannot be found (Cyert and March, 1992). The consequence of this sequential search behavior is that individuals searching on a particular topic will not necessarily consult all the suppliers that offer documents on that topic but are likely to consult a subset of credible suppliers (O'Reilly, Chatman, and Andersen, 1987; Perloff, 1993).

Users can learn about the credibility of alternative information sources by relying on the widespread reputations that suppliers develop in the organization. Suppliers' reputations are helpful to employees searching for knowledge because electronic documents are experience goods whose quality and relevance cannot be fully determined before they are read or used (Nelson, 1970). Employees searching for documents can use suppliers' reputations as a basis for judging the relative merits of alternative document sources when deciding where to allocate their scarce attention in the internal knowledge market (cf. Fombrun and Shanley, 1990). These reputations are constructed as users try out different suppliers, make comparisons between them, form perceptions about the relative merits of alternative suppliers, and share their assessments with others in the organization (Hayward and Boeker, 1998). Through a process of social learning, the experiences and judgments of users affect the perceptions held by other potential users in the organization about the relative merits of particular document sources (Fulk, Schmitz, and Steinfield, 1990; Kraut et al., 1998). Social context thus shapes patterns of information use, helping users to reduce their search costs (Brown and Duguid, 2000).

Document supplier market position. The limited attention of users also has implications for document suppliers, since they have to compete for this scarce resource. Document suppliers in an organization do not all seek the same attention, however, but can be viewed as occupying resource niches in the internal knowledge market that are determined by the content of the documents they supply (cf. McPherson, 1983). Hannan and Freeman (1989) operationalized the concept of a resource niche as a multidimensional space that defines the competitive arena, typically involving a product-market dimension such as the types of menus offered by

restaurants.[3] Analogously, we conceive of two electronic document suppliers as occupying the same resource niche and competing for the limited attention of employees to the extent that they seek to attract users who are looking for the same knowledge content. A focal document supplier that offers the same knowledge content as a number of other suppliers in an organization has a high degree of overlap and operates in a crowded market niche or market segment (Podolny, Stuart, and Hannan, 1996).

Although the concept of market niches based on commonality in attributes can be applied to an internal market for electronic documents, there are some important differences between external product-market competition and knowledge dissemination processes. While firms supply goods and services at a cost, a document supplier in an organization can replicate its electronic documents at a marginal cost of near zero once the documents have been created (Shapiro and Varian, 1999). Moreover, knowledge contained in electronic documents is non-rivalrous (Romer, 1990), in that one user does not deplete the resource available to another user. Thus, in principle, there is no constraint on the dissemination of electronic documents other than the amount of users' attention available.

Since there are limits on attention, however, document suppliers in an information-rich organization cannot expect that individuals searching on a topic will necessarily consult all the relevant sources on that topic. Document suppliers occupying the same internal market segment are therefore likely to be substitute suppliers, rather than complements to each other (Sarvary and Parker, 1997). The implication of occupying a crowded segment in the internal knowledge market is that a focal supplier will find it more difficult to attract the attention of users, who are likely to allocate some of their attention to other suppliers in the same segment. A crowded market position is thus likely to reduce the attention allocated to a focal document supplier.

Strategies to Gain Attention

Although the crowdedness of a market segment constrains the attention allocated to a document supplier, the supplier can engage in publishing strategies to attract the attention of users. Two strategic dimensions are especially relevant. The first dimension is the extent of topic concentration based on the number of topic areas to be covered in the document supply. Choosing to offer documents on many topics is similar to pursuing a generalist strategy based on a broad product line (Carroll, 1985; Kekre and Srinivasan, 1990). The second dimension is the degree of document selectivity. Selective suppliers filter and edit documents to make sure that the documents they supply are of high quality and reduce the total number of documents they offer (cf. Brittain and Freeman, 1980; Porter, 1980).

A document supplier can combine these two dimensions to pursue different publishing strategies, as shown in figure 1. Electronic document suppliers can seek to gain attention by pursuing a less-is-more strategy, covering few topic areas and providing only selected documents on each topic. Such a

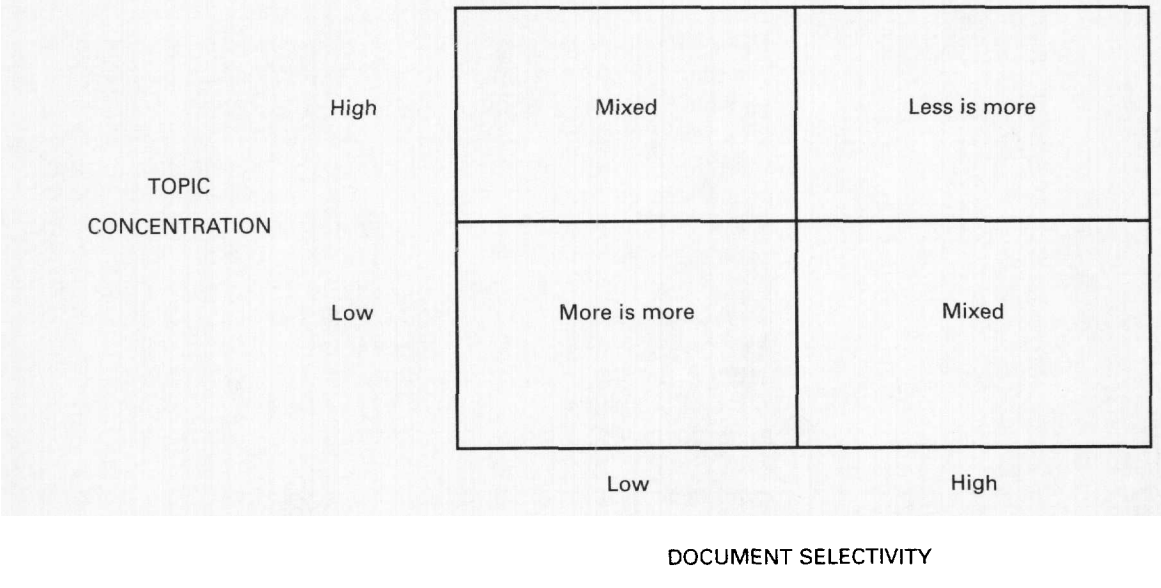
3
More precisely, they distinguished between two types of niches. In this context, the fundamental niche is the one that a document supplier could exploit if there were no competition, while the realized niche is the one that it exploits given a set of competitors. The realized niche is likely to change as the suppliers' competitors change and is the focus of our analysis.

supplier promises users value by supplying a small set of high-quality documents on a few topics on which the supplier is an expert. In contrast, electronic document suppliers can seek to gain attention by pursuing a more-is-more strategy, providing many documents on many topics, thus promising users value by offering extensive choice.

Strategies in crowded segments. Crowded market segments have several distinguishing characteristics relative to uncrowded segments that favor less-is-more electronic document suppliers. Because of the greater overlap among suppliers in crowded segments, users not only have more choice about which document sources to use, they also have a basis for comparing documents offered by different suppliers. Since comparison is feasible, users can make reliable judgments about the value of the documents offered by a supplier relative to those available from similar suppliers, leading to the development of a reputation for quality and relevance among users (Hayward and Boeker, 1998).

Document suppliers that pursue a strategy of selectivity by screening out poor-quality documents can obtain several reputation benefits in crowded segments. Users are likely to appreciate the enhanced quality that comes from being selective, form positive judgments about the supplier, and continue to use the knowledge it provides. In addition, these users are likely to circulate their positive perceptions to other employees, who are then more likely to allocate their attention to the supplier. In contrast, non-selective suppliers are likely to acquire an unfavorable reputation for their documents in crowded segments. Users will have to spend considerable time searching through their supply of non-selective documents to sort high-quality from poor-quality documents, thus essentially doing the screening that the supplier could have done for them. Because wide choice is available and comparison is feasible, users are likely to be able to ascertain

Figure 1. Different publishing strategies for gaining attention.



the relatively low quality of such suppliers, form unfavorable perceptions, and circulate these among colleagues in the organization.[4]

In addition, document suppliers that concentrate on a few topic areas develop expertise about what is relevant and constitutes quality in a certain topic area, thus enabling the supplier to become better at extracting, editing, and codifying knowledge. In contrast, non-concentrated providers are likely to fragment their efforts in extracting, editing, and codifying knowledge to be supplied because they have to cover multiple topics. Such fragmentation is likely to reduce their expertise in any given area, thus making it more difficult to screen out poor-quality documents. Suppliers covering many topics in crowded segments are therefore likely to suffer from the "jack-of-all-trades" problem by having less expertise in each topic area compared with a specialist (Hannan and Freeman, 1989: 105). Thus, lack of concentration leads to an unfavorable reputation when comparisons are possible in crowded segments.

Document suppliers that are both selective and concentrated may also develop a distinctive identity that attracts the attention of users. Individuals create distinctive identities by differentiating themselves from others (Snyder and Fromkin, 1980; Brewer, 1991). Likewise, a highly selective supplier can differentiate itself as a high-quality supplier to the extent that other suppliers in the same market segment do not try to do the same. Concentrating on a few topics also allows for the development of a distinctive identity, because users are likely to associate a few topics with the supplier. A distinctive identity is helpful in crowded segments because users may come to view the supplier as a primary high-quality source of documents on certain topics and may therefore both reuse that supplier and recommend it to others. Once a distinctive identity has formed, a supplier may benefit from it long term to the extent that it does not fade quickly, although strong identities may also make it more difficult for suppliers to change publishing strategy and overcome established identities among users (cf. Haveman, 1992).

The consequence of competing in crowded market segments is a paradox of information supply. A supplier that pursues a publishing strategy of being highly selective and concentrated on a few topics provides benefits to users by conserving the time they have to spend sorting through documents. By supplying less information, a supplier gains more attention from users and thus distributes more information (Simon, 1997). In contrast, a supplier that is non-selective and broad-based (i.e., a more-is-more supplier) is unlikely to develop the same level of quality in its supply and create a distinctive identity. As a result, it develops an unfavorable reputation among users in crowded market situations that allow for comparisons of suppliers. This is likely to translate into less attention to its document supply. To summarize in a hypothesis:

Hypothesis 1: In crowded segments, the more selective and concentrated an electronic document supplier, the more attention allocated to that supplier's documents.

4
Although we assume that the network of relations among users is important for reputations about electronic document suppliers to disseminate, an analysis of this role of personal networks goes beyond the scope of this paper.

Strategies in uncrowded segments. In uncrowded segments, the search challenge confronted by users is no longer choosing between a number of suppliers offering similar knowledge but, rather, finding relevant documents on topics that are covered by few suppliers. Users not only have less choice but also cannot easily make comparisons between document suppliers, because there are few suppliers providing similar documents, although there are still some alternative document sources, assuming that a document supplier has at least some overlap with other suppliers. Thus, there is more uncertainty about the underlying quality of the document supply. Users of documents can make inferences about quality based on their own experiences with a supplier's documents or talk to others who have used the source, but with less basis for comparison, they are likely to have less confidence in their ability to assess the quality of the supplier (cf. Festinger, 1954; Podolny, 1994). In the absence of a large choice of suppliers and feasible comparisons, there is more room for a more-is-more document supplier to thrive.

Electronic document suppliers that are not selective or concentrated but offer many documents on many topics are more able to meet the demand of heterogeneous users than are suppliers offering few documents on few topics. First, a non-selective supplier creates more heterogeneity in its document supply, because its relatively large supply of documents on a given topic is likely to include documents that are slightly different. This approach is akin to product suppliers that offer a range of slightly different products and assume that consumers will buy more because of the greater match between consumer preferences and product characteristics (Lancaster, 1990; Sorenson, 2000). The non-selective supplier is likely to develop a reputation for offering a full range of documents on the topics it covers, thus attracting attention from users seeking relevant documents in an uncrowded segment. By selecting only a small set of documents to supply, in contrast, a document supplier is effectively choosing to discard documents that could have been offered to users. A selective supplier thus develops a reputation for offering a more restricted range of documents on its chosen topic areas, reducing some of its potential for gaining attention.

Second, by covering a wide array of topic areas, an electronic document supplier takes advantage of more parts of the internal knowledge market, offering documents that are relevant to a wider set of users. Each topic area represents some market potential, and many topic areas represent more market potential than do few topic areas. The supplier will gain a reputation for providing documents on a wide range of topics and attract the attention of users who are seeking information on diverse topics. In contrast, by concentrating the effort in a few topic areas, a supplier is forgoing the opportunity to supply documents in other areas, further reducing the opportunity for attracting attention in the internal market for documents.

While electronic document suppliers that are not selective or concentrated may enjoy similar benefits in crowded market segments as well, they are at a disadvantage in crowded segments, because it is easier for users to notice the jack-of-

all-trades problem associated with this strategy when comparisons among suppliers are feasible. In uncrowded segments, in contrast, document suppliers offering many documents on many topics are able to exploit large parts of the knowledge market without incurring this penalty. We therefore predict:

Hypothesis 2: In uncrowded segments, the less selective and concentrated an electronic document supplier, the more attention allocated to that supplier's documents.

METHODS

We tested the hypotheses in a study of Centra Consulting (a pseudonym), a professional services firm that provides management consulting, tax, and audit services to corporate clients. Like its competitors, Centra had over the past five years invested substantially in electronic database systems to enable the consultants to share knowledge more effectively (Hansen, Nohria, and Tierney, 1999). To understand the process of knowledge dissemination via the electronic database system in Centra, we conducted 40 open-ended interviews with coordinators of the system, practice group leaders, and consultants. From these interviews, we came to understand the firm's electronic document-sharing practices as an internal market for codified knowledge.

The Internal Knowledge Market

User demand and document supply. The demand for electronic documents at Centra came from approximately 10,000 consultants who worked on two types of projects: developing sales proposals for prospective clients and carrying out engagements for current clients. Consultants benefited from using documents from the database system in their work because they frequently did not have all the experience and knowledge required to carry out all the tasks in a project. While new consultants used the system to acquire knowledge they did not have, more-senior consultants used the system to keep them up to date on new knowledge. Also, the consultants were located in more than 100 offices across the U.S., so the database system provided a means by which they could share knowledge across geographic boundaries.

The documents available through the system could help a consultant get up to speed on a particular business service (e.g., enterprise resource software implementation) or industry (e.g., automotive) and adapt solutions developed for previous clients. For example, a consultant working on an order-handling systems assignment for a client in Atlanta used the database system to locate prior work done on this topic throughout the country (including work plans, solution templates, market segment analysis, interview guides, competitor comparisons, and software code), downloaded the relevant documents, and then modified and incorporated them into the assignment for the Atlanta client.

The supply of documents to the electronic database system was managed by Centra's 43 practice groups. These practice groups were organizational units that were established to promote the sharing of knowledge on specific consulting top-

ics. Each practice group took responsibility for soliciting documents from consultants around the firm on its chosen set of topics, for selecting and editing the documents to be supplied, and for uploading its supply of codified knowledge into an electronic database. Each practice group had a leader, an administrative coordinator, and its own dedicated database, which was connected to a common platform so that all the databases could be accessed through one database system. Because consultants whom we interviewed perceived the practice groups, and not individual document authors, to be the main suppliers of electronic documents at Centra, we selected the practice groups as the units of analysis.

Incentives. Both users (consultants) and suppliers (practice groups) had formal incentives to participate in knowledge dissemination through the document database system. In their annual performance reviews, consultants were evaluated on their utilization of the firm's knowledge, including electronic documents. Low usage of the database system was viewed negatively and impeded the promotion opportunities for lower-level consultants. To assess consultants' usage of the databases, the system was designed so that the number of documents accessed per month by each consultant could be obtained and used as input in performance reviews.

Centra managers also ensured that the practice groups were motivated to disseminate their electronic documents to users of the database system by monitoring the performance of the databases closely. They installed a tracking system that recorded the number of "hits" on each group's database every month—the number of times the database was accessed—and reviewed these statistics regularly. Managers viewed practice groups with more hits as more successful than those with fewer hits, and this information was used in performance reviews.

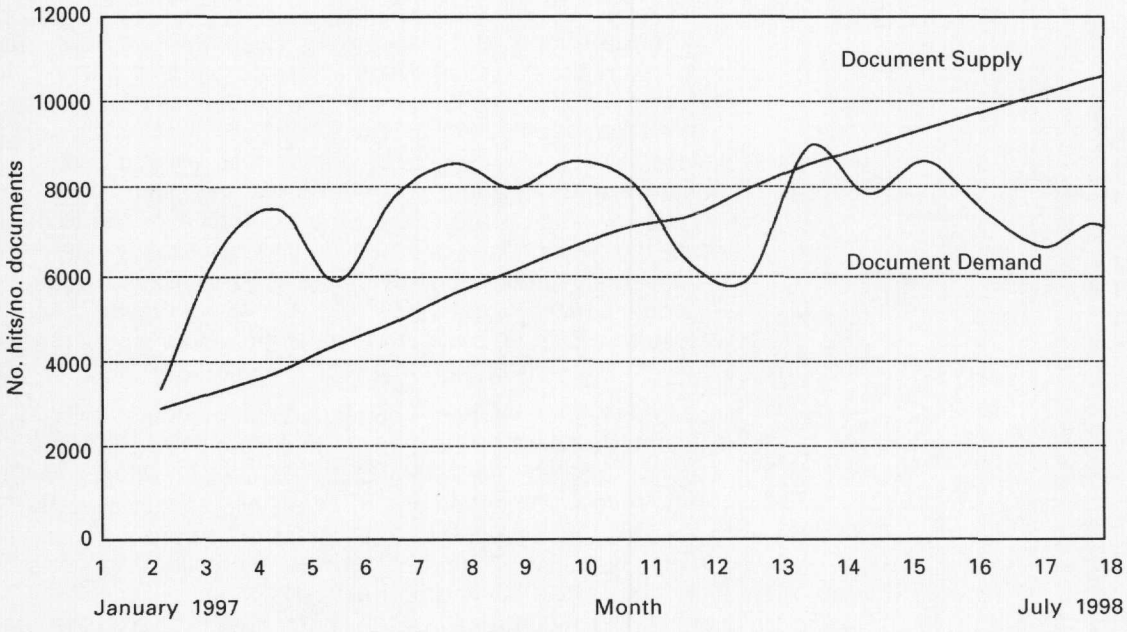
Matching of users and documents. Despite these incentives to use the database system, the process of matching consulting problems with useful documents proved difficult in this information-rich organization. The consultants did not necessarily know where the best and most relevant documents resided. A partner observed, "We have so many webs, knowledge objects, and other sources available to teams that no one knows exactly what is available where." The result was information overload, as exemplified by another partner's recent experience: "I think we were overwhelmed with the material that 'matched' and spent considerable time in pulling the most recent and relevant data."

Managers had developed proprietary search engines to help deal with these issues, but these engines did not solve the matching problem, since they still generated far more documents than were needed and often supplied documents that were irrelevant for a particular problem. As a consequence, consultants talked among themselves to obtain guidance to search the databases more effectively. Database searches were conducted in two ways. The first was to rely on the reputation of a practice group and access that group's database directly. Consultants could then click on a document to open it, generating a hit on that group's database. In the sec-

ond method, consultants used a search engine and entered a keyword to search all the databases. This approach generated a list of documents with the name of the practice group that supplied them next to each one, thus enabling the consultant to screen documents on the basis of the identity and reputation of the practice group. In either way, consultants used the reputation of the practice groups to guide them in their search.

User and supplier learning. During the 18 months we tracked knowledge dissemination at Centra Consulting, the number of electronic documents available through the firm's database system increased from 2000 to 11,000, but demand for documents did not keep pace with the explosion in document supply, as figure 2 shows. During our observation period, demand (as measured by the number of hits on the databases) fluctuated around 7,000 hits in total per month. We interpret this pattern of fairly stable demand as indicative of a ceiling on the amount of attention that the consultants could collectively allocate to the document database system. An alternative interpretation is that some consultants may have downloaded documents early in the observation period and thus satisfied their need for codified knowledge. This is an unlikely explanation for most consultants at Centra, however, because the knowledge required to solve clients' problems changed rapidly, creating a need to acquire new knowledge continually through the system. A more likely explanation is that as the database system became established, the consultants came to learn which document suppliers were good and which were not, through their own expe-

Figure 2. Aggregate demand and supply of electronic documents at Centra Consulting.



Note: Document supply is total number of documents supplied in the practice groups' databases in a given month. Document demand is the total number of monthly hits on the practice groups' databases by the consultants in the company.

riences and through the reputations that the different practice groups quickly developed. Through such a collective learning process, the overall demand for some databases declined while the demand for others increased.

Suppliers also learned about users' preferences. The practice group leaders met regularly with the coordinators and core members of their groups to assess the performance of their databases, but the practice groups varied in how quickly they responded to this feedback or anticipated changing patterns of demand. While some practice groups were proactive and made changes in their publishing strategies during our observation period, others maintained consistent policies throughout the period.

Data Collection

Together with three managers in the firm, we identified 43 practice groups that were in operation at the time of our study. They are listed in table 1. No group had been disbanded prior to our study. Although a consulting topic (e.g., SAP, an enterprise resource-planning system) or an industry (e.g., energy) tended to have a primary group responsible for it, the reality was that the practice groups to varying degrees provided electronic documents on a range of topics. For example, 20 groups provided documents on SAP systems, even though there was one primary group responsible for SAP.

We collected data for every month from January 1997 to July 1998. We chose months as the time unit for analysis because document supply and database usage changed significantly each month (but not each week or day) and was consequently tracked monthly by the managers in the firm. The system went on line in September 1996, with seven

Table 1

List of the 43 Practice Groups in Centra Consulting

Advanced Information Technology	Internal Audit Services
Automotive Suppliers	J. D. Edwards
Business Transformation	JAVA
Communications Solutions	Knowledge Management
Customer Relationship Management	Life Sciences Solutions
Data Warehousing	Managed Care Solutions
Financial Services Solutions	Manufacturing & Industrial Services Solutions
Electronic Commerce	Microsoft
Energy Industry	Multinationals
Energy Solutions	New Product Development
Financial Services Industry	Real Estate and Construction Industry
Health Care Industry	Retail and Consumer Products Industry
Entrepreneurial Services	Retail and Consumer Products Solutions
Entrepreneurial Tax	Retail and Consumer Products Tax
Health Care Business Transformation	SAP
Health Care Management	Shared Support Services
Health Care Materials Management	State and Local Tax
Health Care Physician Practice	Strategic Services
Health Care Clinical Documentation Management Program	Supply Chain Operations
Health Care Revenue Management	Tax Transfer Pricing
Human Resources	Year 2000
Information Security Assurance and Advisory Services	

groups in operation at that time, and the number had grown to 23 groups by January 1997. Because the firm only tracked usage data from January 1997 onward, we were not able to include the first four months of usage in our statistical analysis. We were able to track the groups' document supply activities from their start, however, and therefore avoided any bias resulting from not being able to record group activities during the first four months of operations. To control for any bias resulting from different launch months, we included an age variable that measures the number of months a practice group had been on line (*group age*).

We collected our data from three main sources. First, to gather data on the number and types of documents supplied by the practice groups, we obtained the log files from all 43 databases. Log files listed information on each document, including the date of publication, document title, and a set of keywords describing the content of the document. The second data source was the firm's statistics department, which compiled records of the number of hits on each database per month (i.e., the number of times the database was accessed). The third source was a survey we administered to the groups' coordinators asking about various activities of their practice groups, including questions about publishing policies such as rejection rates and publishing times. The response rate was 100 percent. We also collected information on client billings to construct control variables. Using these data, we created a panel data set in which each group-month was the unit of observation, giving a total of 675 group-month observations for the 43 practice groups over the 18-month period of study.

Variables

Number of database hits. Following Simon's (1997) argument that an individual's allocation of attention can be measured by the amount of time spent on an activity, we measured the allocation of attention to a practice group's document supply by the number of times consultants accessed or hit the database. A hit on a database is evidence of time spent searching through and evaluating the content of that database. We assume that access events on average lasted the same amount of time across databases. While database hits are not evidence of the extent to which consultants read the documents or used them in their work, this limitation is not an issue in our study because we wanted to measure the amount of attention allocated to a database, not the usefulness of the database content. To compute the dependent variable, we aggregated the total number of hits by the firm's consultants on a focal group's database in a month and logged the sum of the monthly hits. We also lagged this variable one month prior to the observation month for the dependent measure and entered the lagged measure as an independent variable.

Crowdedness. We measured the crowdedness of the market segment in which a focal practice group was situated by the extent of overlap in the knowledge content among the groups. To determine content overlap, we used the keywords attached to the documents. Managers at Centra had devel-

oped an extensive taxonomy of keywords for identifying documents, to be used by document authors and group coordinators to indicate the content of the information contained in a document. For example, one document contained the keywords "inbound logistics system, financial services, SAP," denoting that the document was about developing a supplier logistics system using SAP systems in the financial services industry. Since Centra had a predeveloped taxonomy of keywords, authors and coordinators could not simply use whatever words they wanted but had to follow the taxonomy.

Document authors and group coordinators varied in the degree of specificity they chose when assigning keywords, even when they assigned keywords to documents containing information with the same degree of specificity. To avoid bias resulting from this difference, we aggregated keywords to an appropriate level of specificity based on the level of specificity typically used in document searches by consultants. Using this approach, we compiled a list of 101 keywords, a sample of which is listed in table 2. We performed a sensitivity analysis to check whether there were any biases in our aggregation procedure. Having too few keywords on our list could lead us to think there was overlap among groups when there was no overlap, while having too many keywords on the list could lead us to think there was no overlap when there was an overlap. To check for these two biases, we created two alternative lists, one with fewer specific keywords (88 keywords in total) and one with more specific ones (120 in total) than our main set of keywords. We used these alternative

Table 2

Partial List of Keywords Used to Create Crowdedness Measure*

Keyword	No. Documents	No. Groups
Baan	18	6
SAP	367	20
Oracle	21	14
JD Edwards	461	6
Peoplesoft	256	8
Benefits administration	171	17
Compensation & rewards	95	8
Education and career planning	19	3
Recruiting	52	10
Budgeting/forecasting	75	16
Capital & asset management	229	18
Cash management	26	8
Cost management	189	21
Call centers	305	11
Customer acquisition	195	3
Demand & order management	198	9
Banks & depository institutions	106	18
Investment management	46	7
Financing & IPOs	92	16
Mergers & acquisitions	289	12
Pharmaceutical	244	10
Managed care	154	12
Hospital/facility	125	7
Hospital service delivery	79	7

* The number of documents is the total number of documents with the keyword attached. The number of groups is the number of practice groups that had at least one document with the keyword attached.

lists of keywords to create two alternative crowdedness measures, which had partial correlations of 0.92 and 0.98 with the main measure. We ran our models using all three versions, but because the results did not change, we only report the results from using the main taxonomy.

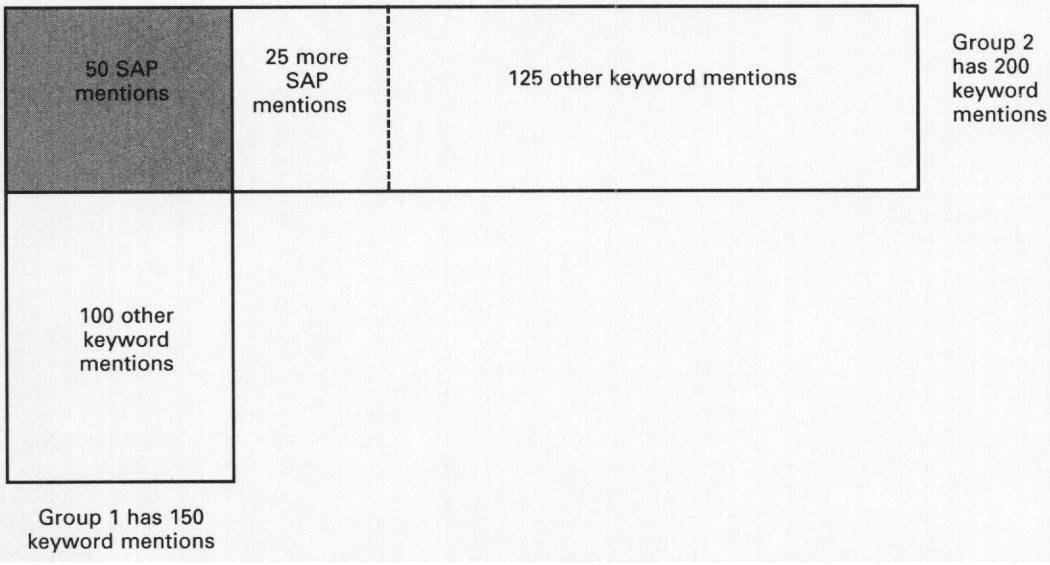
We used the list of 101 keywords to compute the extent of overlap among pairs of practice groups. First, we counted the number of times each keyword category appeared in a group's database in a given month. Over time, as documents with more keyword mentions were added, a group's constellation of keywords changed. Second, we created a nonsymmetric sociomatrix for each month, including groups that were in operation that month. The cells in the sociomatrices contained the keyword overlap between pairs of groups:

$$\text{Dyadic keyword overlap: } \alpha_{ijt} = \sum_{k=1}^{K} m_{ijkt} \Big/ \sum_{k=1}^{K} m_{ikt}$$

where K is the number of keyword categories at time t, m_{ijkt} is the smaller of the number of keyword mentions in a keyword category in both group i and group j at time t, and m_{ikt} is the number of keyword mentions in category k in group i's database at time t. Figure 3 illustrates overlap for two groups that have a common keyword (cf. Podolny, Stuart, and Hannan, 1996). Groups 1 and 2 overlap by having 50 mentions of the keyword "SAP" attached to the documents they supply. For group 1, this constitutes one-third of its total number of keyword mentions that particular month, meaning that α_{12} = .33. That is, group 2 exerts a competitive pressure on group 1 that can be quantified by the fraction 0.33. In contrast, group 2 has a total of 200 keyword mentions, and the common overlap is therefore less for group 2 (i.e., α_{21} = .25).

For a focal group, the sum of the dyadic competition coefficients measures the extent of that group's overlap with all

Figure 3. Illustration of keyword (SAP) overlap for two groups.



the other groups. The higher this overlap, the more crowded the focal group's market segment, because other suppliers are offering much of the same knowledge content. To arrive at the overall crowdedness measure for a group in a given month, we summed the dyadic overlap measures for each month and lagged the measure by one month prior to the observation month for the dependent variable (*crowdedness*):

$$\text{Crowdedness: } \alpha_{it} = \sum_{j=1, j \neq i}^{N} \alpha_{ijt}$$

where N is the number of groups in operation at time t. Two possible issues with the measure need to be addressed. First, two groups are unlikely to have an equal number of keyword mentions in a given category. As illustrated in figure 3, group 2 had 75 SAP mentions but only had an overlap of 50 with group 1, leaving an additional 25 mentions that are not accounted for in the overlap measure. For group 1, the competitive pressure from group 2 may be different because of the additional 25 mentions. To control for this possibility, we created a variable that indicates the total additional keyword mentions by overlapping groups that were not part of the common overlap (i.e., 25 in the example in figure 3). We measured this variable one month prior to the observation month and updated it monthly (*additional count*).

Another issue is the number of keywords attached to each document. Because authors and practice-group coordinators were allowed to assign multiple keywords, documents varied in the number of keywords assigned to them. Although this variation may indicate that some documents covered more topic areas than others, we observed that some groups had a tendency to assign more keywords than others for similar documents. To control for the possibility that our overlap measure is a reflection of this tendency, and not actual similarity in content supply, we created a variable that indicates the number of keyword mentions per document in a given month (*keyword mentions*). We lagged this measure by a month and updated it monthly.

Document selectivity. During preliminary field interviews, we were told that groups followed three related practices to increase selectivity. The first method of being selective was to accept only a subset of those documents submitted for inclusion in the group's database. To screen documents, groups had put in place a review process with a panel of document reviewers. Information on the groups' rejection policies came from the practice-group coordinators' responses to the survey question, "What percentage of documents submitted to your database is typically accepted?," which we reversed scored. We also asked if this proportion had changed much over the study period, but as it had not, we used one measure for each group for the 18-month study period. The rejection rates reported ranged from 0 to 80 percent (*rejection rate*). We also entered a control variable for publication time: a high rejection rate may slow down the time to publication of electronic documents because of the time required to review each document carefully and could result in an outdated and, hence, low-quality document sup-

ply. We asked the coordinators, "On average, how long [in weeks] is the period from date of submission to the date of uploading of new documents in your database?" (*publication time*).

The second method of being selective involved controlling the total number of documents supplied in a group's database. Group coordinators and leaders often scanned the company for useful documents and asked people to write up what they knew about various topics and submit documents to the databases. Some group coordinators and leaders were selective in soliciting submissions, while others scanned widely and solicited many documents. To capture these differences and to measure the effect of total document supply on the ability to attract attention, we used the cumulative number of documents available in a group's database (*total document supply*).[5] We obtained this information from the log file of the 43 databases, lagged the measure by one month, and updated it monthly.

The third way of being selective involved timing the release of documents to avoid batch releases. Some practice groups adopted a batch-release approach, stockpiling large quantities of documents prior to uploading them and then releasing them into the database all at once in one month, while others maintained a continuous supply, providing a smaller set of documents as soon as they were ready for release each month. By selecting a smaller set of documents to publish each month, practice groups that avoided batch releases could help consultants conserve their attention. To measure the extent to which a group used batch releases, we registered a batch release as occurring in a given month if the number of documents released to the database was 10 times larger than the documents released in the prior and subsequent months in that database. We created a dummy variable that took on a value of 1 if there had been such a spike in the two months prior to the observation month, and zero otherwise, and updated this measure monthly (*batch release*). To test whether these three different selectivity variables had different impacts in uncrowded and crowded niches, we interacted each of them with the crowdedness measure.

Document concentration. We used the Herfindahl index from strategic management research to measure the extent to which a group operated in a few or many topic areas (e.g., Acar and Sankaran, 1999). This measure indicates the degree of concentration in a set of elements, that is, in the 101 topic areas in our keyword list (*concentration*). The measure is:

$$H = \sum_i p_i^2$$

where p_i is the fraction of a group's total keyword mentions in the ith topic area in the main taxonomy list at time t. This measure ranges from 1/n to 1, where n is the total number of elements, that is, the 101 keyword categories in our main taxonomy. If a practice group has all its documents in one keyword category, then this measure is 1.

5
A potential bias with this document count is that some groups may have supplied longer documents than others, thus supplying more information. Because the size of each document (measured by bits) was also listed, however, we were able to determine that the average size of documents did not vary across groups, so we did not create a separate variable for this dimension.

Strategic management scholars have also used the so-called entropy measure as an alternative to the Herfindahl index (Palepu, 1985). This is defined by:

$$E = -\sum_i p_i \log p_i$$

This measure more directly indicates the extent of diversification across a set of elements and is therefore appropriate in research on company diversification. Because we were mainly interested in the degree of concentration, we relied primarily on the Herfindahl measure but also report results using the entropy measure (*entropy*). The two measures are highly correlated in our data set ($r = -0.91$).

Control Variables

Monthly dummy variables. We included variables to control for the aggregate attention capacity or "carrying capacity" of the system—that is, all consultants' inclination to use the databases in a given month (Hannan and Freeman, 1989), which varied from month to month over the 18 months of observation. We controlled for these differences across time because our theory suggests that groups will compete for attention given a finite level of total capacity for attention. We entered 17 month dummy variables, each taking on a value of 1 if the observation was in that month, and 0 otherwise, with the last month as the omitted category.

Demand and growth. Groups experienced different levels of underlying demand for their documents, depending on the work needs of the consultants. To address this unobserved heterogeneity, we entered two control variables. We first constructed a variable that indicates the level of client billings that could be attributed to the primary service or industry area of each practice group (*revenues*). Billings associated with a service or industry indicated the level of consulting activity in that area. We obtained billing data for all the major service and industry areas at Centra from the firm's billing database and created a four-point variable based on quartiles of billing levels. A value of 4 indicates that the billings attributed to the service or industry area of the group were in the highest quartile of group revenues during the study period; a value of 1 indicates billings in the lowest quartile.

We also constructed a variable measuring growth in revenues, using billing data for two fiscal years to measure growth. A group may supply documents on consulting activity areas that are growing quickly, implying that there is more demand for these types of documents. Revenue growth was measured on a four-point scale, by allocating growth into "very high growth," "medium growth," "low growth," and "no growth or decline" categories (*revenue growth*).

Knowledge codification. The groups also varied in the type of knowledge they supplied. In particular, practice groups focusing on inherently tacit knowledge should receive fewer hits because the knowledge about their topics had to be communicated through non-electronic means, such as strong personal ties between the source and recipients (Hansen,

1999). To control for this variation among the groups, we asked the coordinators to indicate, on a 7-point scale, the extent to which knowledge about the topics they covered was codified. We asked three questions developed by Hansen (1999): "How well documented is all the knowledge that is used in selling or delivering client projects in your areas?" (with anchors of "it is not well documented" and "it is very well documented"); "Is all the knowledge that is used in selling or delivering projects in your areas sufficiently explained in written documents?" (with anchors of "none of it is" and "all of it is"); and "What type of knowledge is used in selling and delivering client projects in your areas?" (with anchors of "mainly personal practical know-how" and "mainly reports, manuals and documents"). We averaged the responses to these three 7-point scales to create a measure of codification that had a Cronbach alpha of .72 (*knowledge codification*).[6]

Statistical Approach

We used a random-effects specification in our regression analysis to control for the possibility of unobserved heterogeneity between groups in the pooled cross-sectional time series data (Greene, 1993). This specification allows for the inclusion of time-invariant covariates, whereas the alternative of using fixed-effects models does not. Since the survey data produced only one value for the rejection-rate policy and publication-time variables for each group, these covariates were time-invariant. To test the validity of the random-effects specification, we performed the Hausman (1978) test, which checks whether the assumption that the random effect is not correlated with the other regressors in the model is violated. The assumption was not violated in our data set. We estimated the following model:

$$\ln(Y_{i,t}) = \alpha + \gamma \ln(Y_{i,t-1}) + \beta' X_{i\ i,t-1} + \mu_i + \varepsilon_{i,t}$$

where $Y_{i,t}$ is the number of hits on practice group i's database in month t, $Y_{i,t-1}$ is the lagged dependent variable, $X_{i,t-1}$ is a vector of lagged independent variables (including the month dummies), β' is a transposed matrix of coefficient scalars, the component μ_i is the disturbance characterizing the ith practice group and is constant through time, and $\varepsilon_{i,t}$ is the remaining random disturbance.

RESULTS

Descriptive statistics are reported in table 3. We standardized the main independent variables (by subtracting the mean and dividing by the standard deviation) to avoid high levels of multicollinearity between these variables and the interaction terms.

The results for the random effect models are reported in table 4. Model 1 reports the baseline model including the effects of the monthly dummy variables but excluding the effects of the independent variables. The one-month lag of the dependent variable is positive, but the coefficient estimate is below 1, which indicates that as the groups grow

6
We also conducted analysis with other control variables, notably variables that indicated the credibility of practice groups. Groups could rely on high-status affiliate members (especially partners, who were senior consultants in the firm) to signal legitimacy, serving as a cue for consultants when they were conducting searches for documents. We included a variable indicating the number of partners affiliated with a group, but as this variable did not change any of the results, we excluded it in the analysis reported here.

Table 3

Descriptive Statistics and Partial Correlations (N = 675)

Variable	Mean	S.D.	Min.	Max.	1	2	3	4
1. No. hits (dep. var.)	5.67	1.61	0	9.15				
2. No. hits (dep. var. lagged)	5.63	1.60	0	9.15	.94			
3. Revenue	2.21	1.26	1	4	.46	.45		
4. Revenue growth	2.90	.99	1	4	.18	.17	.12	
5. Group age	12.91	5.43	1	22	.13	.24	.25	.01
6. Knowledge codification	4.23	1.06	2.13	6.17	–.01	–.01	–.08	.10
7. Additional count	97.90	61.78	0	335	–.12	–.13	–.08	–.05
8. Keyword mentions	2.20	3.52	1	46	.02	.02	–.07	–.15
9. Publication time	5.27	3.68	1	17	–.39	–.40	–.09	–.22
10. Crowdedness*	0	1.00	–1.78	3.29	–.17	–.18	–.04	–.23
11. Concentration*	0	1.00	–1.10	4.12	–.21	–.22	–.31	.02
12. Concentration x crowdedness	.12	1.70	–5.72	13.53	.01	0	.07	.06
13. Tot. document supply*	0	1.00	–1.09	6.03	.41	.44	.13	.17
14. Rejection rate*	0	1.00	–1.12	2.58	–.01	–.01	–.05	.07
15. Batch release*	0	1.00	–.23	4.40	–.15	–.13	–.18	.00
16. Doc. supply x crowdedness	–.27	.84	–3.89	1.93	–.08	–.08	–.12	0
17. Rejection x crowdedness	.03	1.02	–4.11	4.05	–.08	–.08	–.01	–.06
18. Batch x crowdedness	–.03	.79	–5.84	7.72	–.03	–.01	.05	–.29

Variable	5	6	7	8	9	10	11
6. Knowledge codification	–.04						
7. Additional count	.58	–.08					
8. Keyword mentions	–.00	–.02	–.13				
9. Publication time	–.10	–.12	.19	–.03			
10. Crowdedness*	.27	–.22	.45	–.10	.16		
11. Concentration*	–.22	–.10	.10	–.08	.03	.05	
12. Concentration x crowdedness	.04	–.14	.18	–.01	–.03	.12	–.10
13. Tot. document supply*	.39	.17	–.19	–.13	–.25	–.49	–.25
14. Rejection rate*	–.02	.15	0	.32	–.08	–.02	.03
15. Batch release*	–.06	.17	–.01	–.05	.10	–.01	.06
16. Doc. supply x crowdedness	–.20	–.09	–.02	.01	.01	–.17	–.04
17. Rejection x crowdedness	–.08	–.12	.17	.03	.01	.17	–.12
18. Batch x crowdedness	.11	–.01	–.03	.02	–.04	–.11	–.02

Variable	12	13	14	15	16	17
13. Tot. document supply*	.08					
14. Rejection rate*	–.14	.08				
15. Batch release*	–.02	–.01	–.04			
16. Doc. supply x crowdedness	–.32	–.28	–.37	.07		
17. Rejection x crowdedness	–.11	–.29	–.07	.03	.44	
18. Batch x crowdedness	–.03	.05	.03	–.03	.02	.11

* Variable is standardized by subtracting the mean from the value and dividing by the standard deviation.

larger, their growth in additional hits increases at a decreasing rate. This result is consistent with other organization growth studies (Tuma and Hannan, 1984). Model 2 includes the effects of the crowdedness measure. The result is negative and significant throughout the models in table 4. The higher a focal group's overlap with other groups in a month, the fewer the hits on the focal group's database in the next month. That is, an increase in the degree of crowdedness in a group's internal market segment negatively affects the amount of attention allocated to the group by users of the database system.

The results reported in models 3 through 5 present the effects of the topic concentration measures. As shown in model 4, the main effect for the topic concentration measure (i.e., the Herfindahl index) is negative and significant, while the interaction term including the concentration and crowded-

Table 4

Effects from Regression Analysis of Monthly Database Hits (N = 675)*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Intercept	2.076•	2.072•	2.141•	2.589••	2.619••	2.442•	2.604•	2.409•	2.494•
	(1.080)	(1.091)	(1.102)	(1.150)	(1.146)	(1.218)	(1.282)	(1.315)	(1.317)
No. hits (lagged)	.334•••	.326•••	.323•••	.302•••	.301•••	.301•••	.275•••	.268•••	.267•••
	(.029)	(.030)	(.030)	(.030)	(.030)	(.030)	(.030)	(.030)	(.030)
Revenues	.164•	.165•	.159	.158	.153	.154	.144	.134	.137
	(.097)	(.098)	(.099)	(.103)	(.102)	(.109)	(.115)	(.117)	(.118)
Revenue growth	.030	.020	.024	.006	−.002	.008	−.003	.023	.018
	(.104)	(.105)	(.106)	(.111)	(.110)	(.116)	(.122)	(.125)	(.126)
Group age	.072	.072	.071	.062	.061	.071•	.077	.084	.081
	(.045)	(.046)	(.046)	(.048)	(.048)	(.052)	(.055)	(.056)	(.056)
Knowledge codification	−.034	−.038	−.040	−.059	−.056	−.051	−.068	−.064	−.063
	(.102)	(.103)	(.104)	(.108)	(.107)	(.115)	(.121)	(.124)	(.124)
Additional count	−.000	.000	.000	.000	.000	.000	.000	.000	.000
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Keyword mentions	.020	.020••	.020••	.018••	.019••	.018••	.019••	.021•••	.021•••
	(.008)	(.008)	(.008)	(.008)	(.008)	(.008)	(.008)	(.008)	(.008)
Publication time	−.060••	−.060••	−.060••	−.061••	−.060••	−.062••	−.068••	−.066••	−.067••
	(.028)	(.028)	(.028)	(.030)	(.029)	(.031)	(.033)	(.034)	(.034)
Crowdedness†		−.079••	−.068••	−.163•••	−.167•••	−.191•••	−.293•••	−.296•••	−.290•••
		(.038)	(.034)	(.057)	(.059)	(.060)	(.063)	(.063)	(.063)
Concentration†			−.040	−.093••		−.084••	−.099••	−.107••	−.117•••
			(.040)	(.042)		(.043)	(.042)	(.042)	(.043)
Concentration x crowdedness				.083•••		.086•••	.073•••	.077•••	.083•••
				(.022)		(.022)	(.022)	(.022)	(.022)
Entropy†					.113••				
					(.056)				
Entropy x crowdedness					−.125•••				
					(.029)				
Tot. document supply†						−.072	−.139•••	−.144•••	−.147•••
						(.050)	(.052)	(.052)	(.052)
Rejection rate†						.026	−.026	−.029	−.028
						(.112)	(.118)	(.121)	(.121)
Batch release†						−.101	−.093	−.099	−.117•
						(.094)	(.093)	(.093)	(.070)
Tot. doc. x crowdedness							−.221•••	−.233•••	−.231•••
							(.051)	(.051)	(.051)
Rejection x crowdedness								.076••	.074••
								(.038)	(.037)
Batch release x crowdedness									−.242••
									(.121)
R^2	.905	.918	.919	.924	.924	.925	.932	.939	.945

• $p < .10$, •• $p < .05$, and ••• $p < .01$; two-tailed test for variable coefficients.
* Standard errors are in parentheses. Effects for monthly dummy variables are not shown.
† Variable is standardized by subtracting the mean and dividing by the standard deviation.

ness variables is positive and significant. That is, as segments become more crowded, an increase in the degree of concentration positively affects the number of hits on a database. This result supports hypothesis 1, that there is a positive effect of topic concentration on attention in crowded market segments. The results for the entropy measure are the same (see model 5). Because this variable measures topic breadth, not concentration, the effects have opposite signs, such that an increase in the entropy variable leads to a negative effect on database hits with increasing degrees of market crowdedness.

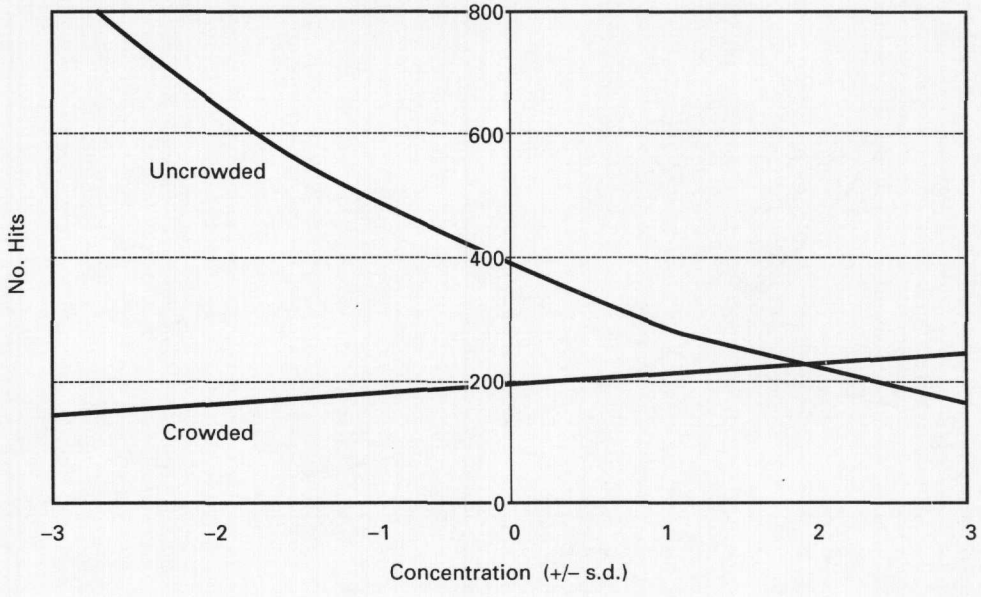
To assess the net effect of concentration, both the main effect and the interaction effect need to be considered, as follows (using estimates from model 4):

$$\text{No. hits} = \exp[-.093*\text{concentration} + \text{crowdedness}*(.083*\text{concentration})] \quad (1)$$

The combined effects reveal that a fairly high level of crowdedness (i.e., more than 1.12 standard deviations above the mean) is needed for the positive interaction effect to surpass the negative main effect of being concentrated. The results are plotted in figure 4 for various levels of topic concentration in uncrowded niches (i.e., two standard deviations below the mean) and crowded niches (i.e., two standard deviations above the mean). In uncrowded niches, practice groups that had low levels of concentration (i.e., supplied a broad product line) received more database hits. In crowded niches, in contrast, practice groups that concentrated their document supply in a few keyword categories enjoyed more database hits. While the slope of this line is not as steep as the one for uncrowded segments, the effect is still substantial. For example, a practice group that shifted from a low concentration level (–2 s.d.) to a high level (+2 s.d.) would increase the number of monthly database hits from an estimated 182 to 240, an increase of 31 percent. These results confirm hypotheses 1 and 2.

The results for the three document selectivity variables are entered in models 6 through 9. The main effect and the interaction effect for the total number of documents supplied are both negative and significant, as shown in model 7. With an increase in a focal group's crowdedness, an increase in the total document supply has a negative effect on the number of database hits. The net effect of total document supply is as follows:

Figure 4. Plot of the effects of topic concentration on the number of database hits.



Note: No. of hits includes the effects for the intercept, the main effect of crowdedness (estimated at either +2 or –2 s.d. from the mean), and all other variables included in model 4 (estimated at their mean level).
Crowded (+2 s.d.): No. hits = exp [–0.093* concentration + 2 *(0.083*concentration)]
Uncrowded (–2 s.d.): No. hits = exp [–0.093* concentration –2 *(0.083*concentration)].

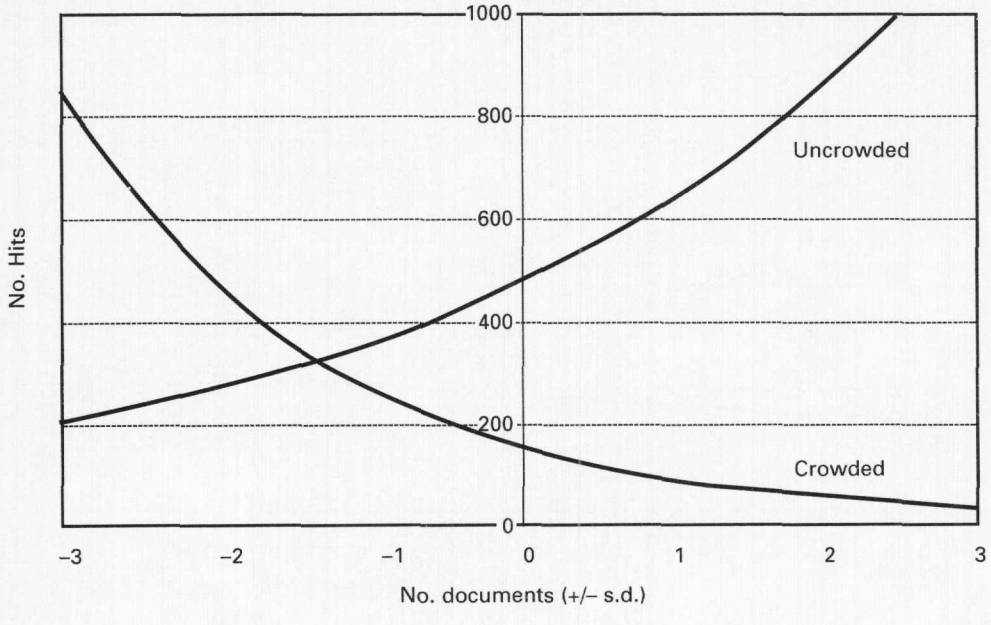
$$\text{No. hits} = \exp\,[-0.139*\text{tot.documents} + \text{crowdedness}*(-.221*\text{tot.documents})]. \quad (2)$$

When the crowdedness measure is 2 (i.e., two standard deviations above the mean), this becomes a net negative effect, but when the crowdedness measure is –2 (i.e., two standard deviations below the mean), this becomes a net positive effect.[7] The magnitude of the estimates are plotted in figure 5, which depicts the contrasting effects of increasing document supply in crowded and uncrowded niches, respectively. These results confirm hypotheses 1 and 2, that large document supplies lead to more attention in the form of database hits in uncrowded niches but lead to less attention in crowded ones.

The results for rejection rate and batch releases are similar. Practice groups in crowded niches that pursued a strategy of selectivity based on a high rejection rate and no batch releases attracted more attention to their database. In contrast, groups in uncrowded niches that pursued a strategy of a high rejection rate and no batch releases attracted less attention than those that were not selective. These results also lend support to hypotheses 1 and 2. Interestingly, the estimate for publication time is negative and significant, indicating that controlling for rejection rates, groups that took longer from the time they received a document from an author until they made it available in the database received fewer hits on their database.

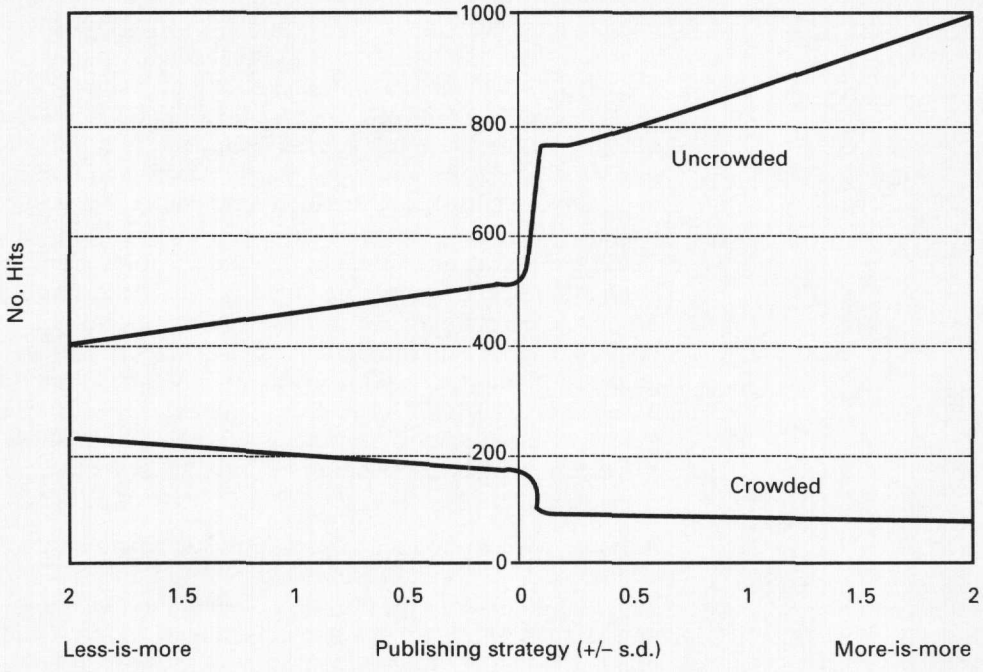
7
Because the coefficient estimate for the main effect of document supply is negative, it is not obvious that the combined net effect is positive. This result is obtained because of the minus sign for the crowdedness measure, which causes the sign for the interaction coefficient to be positive. In another model (not reported here), we used non-standardized measures and obtained the same net positive effect under conditions of high crowdedness. See the equations listed in figure 5.

Figure 5. Plot of the effects of total document supply on the number of database hits.



Note: No. of hits includes the effects for the intercept, the main effect of crowdedness (estimated at either +2 or –2 s.d. from the mean), and all other variables included in model 7 (estimated at their mean level). Whether the net effect is negative or positive depends on the sign of the crowdedness variable:
Crowded (+2 s.d.): No. hits = exp [–0.139* tot. documents + 2 *(–.221*tot. documents)]
Uncrowded (–2 s.d.): No. hits = exp [–0.139* tot. documents –2*(–.221 *tot. documents)].

Figure 6. Plot of the effects of two publishing strategies on the number of database hits.



Note: No. of hits includes the effects for the intercept, the main effect of crowdedness (estimated at either +2 or –2 s.d. from the mean), and all other variables included in model 9 (estimated at their mean level). Publishing strategy is a combination of four variables (topic concentration, total document supply, rejection rate, and batch release). The discontinuous change in the two slopes is due to the inclusion of the batch release dummy variable, which is set to 0 when publishing strategy is less-is-more (left side of the graph), and 1 when the publishing strategy is more-is-more (right side of the graph).

We have plotted the combined effects of the four main independent variables in figure 6. Document suppliers that pursued a less-is-more publishing strategy were those with a high level of topic concentration (i.e., with 0 to 2 standard deviations above the mean), few documents (with 0 to 2 standard deviations below the mean), a high rejection rate (with 0 to 2 standard deviations above the mean), and no batch releases (i.e., dummy variable set to 0). Likewise, document suppliers that pursued a more-is-more strategy were those with a low level of topic concentration, many documents, a low rejection rate (i.e., with 0 to 2 standard deviations below or above the mean for these variables), and batch releases (i.e., dummy variable set to 1). As figure 6 shows, our two hypotheses were confirmed. In crowded segments, a shift in publishing strategy from a more-is-more to a less-is-more profile led to an increase in database hits, supporting hypothesis 1. In uncrowded segments, in contrast, a shift in publishing strategy from a less-is-more to a more-is-more profile led to a substantial increase in the number of monthly database hits. This result supports hypothesis 2.

DISCUSSION

The main finding of this study is that the process of knowledge dissemination in an organization can usefully be ana-

lyzed as an internal knowledge market in which users form perceptions about suppliers based on their publishing strategies and in which suppliers compete for the limited attention of users. The outcome of this contest determines what knowledge gets disseminated in an organization. Previous researchers have viewed the process of knowledge dissemination as a message transmission problem (e.g., Shannon and Weaver, 1949), a transfer problem between two parties (e.g., Zander and Kogut, 1995), a diffusion problem (e.g., Rogers, 1983), or a search problem (e.g., Cyert and March, 1992) but not as a problem of competition between suppliers in an internal knowledge market. One reason for the lack of emphasis on competition in a knowledge market is that the constraining effects of users' limited attention have been less salient in organizational contexts in which information is not widely available. Our findings suggest, however, that new insights can be gained from addressing the other aspect of the problem: how suppliers of information attract users when there is plenty of information but a scarcity of attention.

Although we studied a company that had made an unusually large investment in an electronic document system and thus had created a very rich information environment, more companies are likely to be in a similar situation as more information is made readily available through electronic sharing systems (Sproull and Kiesler, 1991). This profound shift from information scarcity to information richness requires new organization theory. Our suggestion is to develop a more comprehensive theory of internal knowledge markets in information-rich environments, including a broader treatment of knowledge suppliers, users, and their relational aspect.

On the document-supplier side, our empirical findings suggest that an electronic document supplier's ability to disseminate its knowledge in an organization is affected by the crowdedness of its market segment, lending validity to an intraorganization ecological view of competition among knowledge suppliers (e.g., Burgelman, 1991). This ecological view can be extended in several ways. While our study was limited to the analysis of competition among knowledge-supplying groups in one company, other studies could treat items of information (e.g., individual documents) or individuals (e.g., authors) as the unit of analysis. For example, in other organizational settings, authors of documents may compete for the attention of other employees, as the practice groups at Centra Consulting competed for consultants' attention. In addition, our study did not address the dissemination of other types of knowledge (e.g., individual tacit knowledge) or other sharing mechanisms (e.g., personal relations or e-mail). These alternative forms of knowledge and mechanisms may be amenable to a knowledge-market view. For example, e-mail messages are likely to compete for the limited attention of employees, as are internal experts who seek to be consulted to legitimize their existence.

Focusing exclusively on competition among document suppliers, however, is likely to yield a limited view of internal markets for electronic information. As we argued in the theory section, users form and share opinions about different suppliers and thus create a social context that affects patterns of

knowledge dissemination in the organization (Brown and Duguid, 2000). Ecological models thus need to be extended from a supply-side focus to a more relational view in which both suppliers and users are considered. Several unanswered research questions can be addressed to develop a fuller understanding of the processes by which users learn how to find and use the electronic information they need in information-rich organization contexts. For example, while we assumed that users circulated their perceptions about the practice groups at Centra through personal networks, researchers can study how users rely on social networks to learn about and form judgments about electronic document suppliers. Do users with social networks rich in structural holes better learn about reliable suppliers because they have access to more diverse information through non-redundant contacts (Burt, 1992)? In addition, while our study was limited to the allocation of attention to information sources, research also needs to address the usefulness of finding and using electronic documents. For example, do users who rely on other people in their network to point them to useful electronic documents perform better than individuals who do not benefit from such personal recommendations?

There are also interaction effects between users and suppliers in an internal knowledge market. Electronic document suppliers are likely to learn about users both through their own experiences and through the experiences of other suppliers. To analyze these dynamics, future research can address the extent to which document suppliers respond to usage behaviors by altering their publishing strategies and the implications for their ability to attract attention. Over time, suppliers may learn which publishing strategies work in given market segments by experimenting with different strategies. Document suppliers may also learn from the usage experience of other suppliers in their organization, either by imitating their practices or by collaborating with them to transfer best publishing practices. But such cross-supplier learning may be hindered by group leaders and coordinators who are vying for the same promotion opportunities in an organization and thus have little incentive to share practices that might make other groups look better.

In short, this broader conceptualization of an internal knowledge market extends beyond a pure ecological model of competition in markets and suggests that a solely supplier-oriented view of internal knowledge markets is a limited one, since users' social constructions and patterns of demand also affect competitive dynamics. Intraorganizational markets offer an interesting and tractable venue for expanding supply-side conceptions of competition by incorporating demand-side processes and the dynamic relations between suppliers and users.

The final set of implications of this research involves competition for attention among organizations that supply knowledge. While knowledge-supplying organizations, such as Web site businesses or academic journals, in principle can disseminate their knowledge at a very low marginal cost (Shapiro and Varian, 1999), the main constraint for successful knowledge dissemination in the interorganizational market is the

limited amount of time people have to consult this knowledge, by visiting Web sites or reading journals, for instance. From the perspective of a knowledge-supplying organization, this constraint is especially acute in crowded market segments, in which a number of similar suppliers compete for the same attention capacity. For example, if we apply our finding to external Web sites, we may expect that a Web site in a crowded market segment will attract more attention (i.e., hits) to the extent that it is more selective and concentrated, because it provides value to consumers by screening out poor-quality information and by including only high-quality information on a small set of topics. From our casual observation, however, Web site managers appear to pursue the opposite strategy, believing that crowded market segments require the supply of more information, not less. That is, managers who confront high volumes of information provided by competing Web sites seem to counterattack with still more information in order to gain the attention of consumers. Such behavior may create an information cycle that spins out of control: Web sites offer more information to consumers, whose capacity to attend to this information becomes increasingly constrained, leading consumers to pay less attention on average to each Web site, which in turn responds by increasing the information supply to gain more attention, and so on.

Furthermore, there appears to be a belief that any information overload problem can be addressed by installing more advanced search engines, rather than by reducing or managing the supply of information. Subsequent studies can test the hypothesis that such beliefs are fallacious, because a more-is-more strategy of a large information supply may actually reduce Web site hits in crowded segments of the market space. In short, our findings about competition for the attention of employees in a company can usefully be extended to studies that seek to understand how knowledge-supplying organizations compete for the attention of consumers in markets where there is a proliferation of information but a scarcity of attention.

REFERENCES

Acar, W., and K. Sankaran
1999 "The myth of unique decomposability: Specializing the Herfindahl and entropy measures?" Strategic Management Journal, 20: 969–975.

Althauser, R. P.
1989 "Internal labor markets." Annual Review of Sociology, 15: 143–161. Palo Alto, CA: Annual Reviews.

Bank, D.
1997 "Visual navigation techniques may help alleviate information overload." Wall Street Journal, June 27: B4.

Blau, P. M.
1964 Exchange and Power in Social Life. New York: Wiley.

Brewer, M. B.
1991 "The social self: On being the same and different at the same time." Personality and Social Psychology Bulletin, 17: 475–482.

Brittain, J. W., and J. H. Freeman
1980 "Organizational proliferation and density dependent selection." In J. R. Kimberly, R. H. Miles and associates (eds.), The Organizational Life Cycle: 291–338. San Francisco: Jossey-Bass.

Brown, J. S., and P. Duguid
2000 The Social Life of Information. Boston: Harvard Business School Press.

Burgelman, R. A.
1991 "Intraorganization ecology of strategy-making and organization adaptation: Theory and field research." Organization Science, 2: 239–262.

Burt, R. S.
1992 Structural Holes: The Social Structure of Competition. Cambridge, MA: Harvard University Press.

Carroll, G. R.
1985 "Concentration and specialization: Dynamics of niche width in populations of organizations." American Journal of Sociology, 90: 1262–1283.

Cyert, R. M., and J. G. March
1992 A Behavioral Theory of the Firm, 2d ed. Cambridge, MA: Blackwell Business.

Daft, R. L., and R. H. Lengel
1984 "Information richness: A new approach to managerial behavior and organization design." In B. M. Staw and L. L. Cummings (eds.), Research in Organizational Behavior, 6: 191–233. Greenwich, CT: JAI Press.

Festinger, L.
1954 "A theory of social comparison processes." Human Relations, 7: 117–140.

Fombrun, C., and M. Shanley
1990 "What's in a name? Reputation building and corporate strategy." Academy of Management Journal, 33: 233–258.

Fulk, J., J. Schmitz, and C. W. Steinfield
1990 "A social influence model of technology use." In J. Fulk and C. W. Steinfield (eds.), Organizations and Communication Technology: 117–140. Newbury Park, CA: Sage.

Galbraith, J. R.
1973 Designing Complex Organizations. Reading, MA: Addison-Wesley.

Greene, W. H.
1993 Econometric Analysis, 2d ed. New York: Macmillan.

Hannan, M. T., and J. Freeman
1989 Organizational Ecology. Cambridge, MA: Harvard University Press.

Hansen, M. T.
1999 "The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits." Administrative Science Quarterly, 44: 82–111.

Hansen, M. T., N. Nohria, and T. Tierney
1999 "What's your strategy for managing knowledge?" Harvard Business Review, 77 (March–April): 106–116.

Hausman, J.
1978 "Specification tests in econometrics." Econometrica, 46: 1251–1271.

Haveman, H.
1992 "Between a rock and a hard place: Organizational change and performance under conditions of fundamental environmental transformation." Administrative Science Quarterly, 37: 48–75.

Hayward, M. L., and W. Boeker
1998 "Power and conflicts of interest in professional firms: Evidence from investment banking." Administrative Science Quarterly, 43: 1–22.

Huber, G. P., and R. L. Daft
1987 "The information environments of organizations." In F. M. Jablin, L. L. Putnam, K. H. Roberts, and L. W. Porter (eds.), Handbook of Organizational Communication: 130–164. Newbury Park, CA: Sage.

Hunt, R. E., and R. G. Newman
1997 "Medical knowledge overload: A disturbing trend for physicians." Health Care Management Review, 22: 70–75.

Kekre, S., and K. Srinivasan
1990 "Broader product line: A necessity to achieve success?" Management Science, 36: 1216–1231.

Kraut, R. E., R. E. Rice, C. Cool, and R. S. Fish
1998 "Varieties of social influence: The role of utility and norms in the success of a new communication medium." Organization Science, 9: 437–453.

Lancaster, K. J.
1990 "The economics of product variety: A survey." Marketing Science, 9: 189–206.

March, J. G., and J. P. Olsen
1976 Ambiguity and Choice in Organizations. Bergen, Norway: Universitetsforlaget.

McPherson, M.
1983 "An ecology of affiliation." American Sociological Review, 48: 519–532.

Nelson, P.
1970 "Information and consumer behavior." Journal of Political Economy, 78: 311–329.

Ocasio, W.
1997 "Towards an attention-based view of the firm." Strategic Management Journal, 18 (summer special issue): 187–206.

O'Reilly, C. A., J. A. Chatman, and J. C. Anderson
1987 "Message flow and decision-making." In F. M. Jablin, L. L. Putnam, K. H. Roberts, and L. W. Porter (eds.), Handbook of Organizational Communication: 600–623. Newbury Park, CA: Sage.

Palepu, K.
1985 "Diversification strategy, profit performance and the entropy measure." Strategic Management Journal, 6: 239–255.

Perloff, R. M.
1993 The Dynamics of Persuasion. Hillsdale, NJ: Erlbaum.

Pfeffer, J.
1994 Competitive Advantage Through People. Boston: Harvard Business School Press.

Pitney Bowes
1997 Pitney Bowes Managing Corporate Communications Study. Stamford, CT: Pitney Bowes.

Podolny, J. M.
1994 "Market uncertainty and the social character of economic exchange." Administrative Science Quarterly, 39: 458–483.

Podolny, J. M., T. E. Stuart, and M. T. Hannan
1996 "Networks, knowledge and niches: Competition in the worldwide semiconductor industry, 1984–1991." American Journal of Sociology, 102: 659–689.

Polanyi, K.
1944 The Great Transformation. New York: Farrar & Rinehart.

Porter, M. E.
1980 Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: Free Press.

Reuters
1998 Out of the Abyss: Surviving the Information Age. London: Reuters Limited.

Rogers, E. M.
1983 Diffusion of Innovations, 3rd ed. New York: Free Press.

Romer, P. M.
1990 "Endogenous technological change." Journal of Political Economy, 98: 71–102.

Sarvary, M., and P. M. Parker
1997 "Marketing information: A competitive analysis." Marketing Science, 16: 24–38.

Shannon, C. E., and W. Weaver
1949 The Mathematical Theory of Communication. Urbana, IL: University of Illinois Press.

Shapiro, C., and H. Varian
1999 Information Rules: A Strategic Guide to the Network Economy. Boston: Harvard Business School Press.

Simon, H. A.
1997 "Designing organizations for an information-rich world." In D. M. Lamberton (ed.), The Economics of Communication and Information: 187–203. Cheltenham, UK: Edward Elgar.

Snyder, C. R., and H. L. Fromkin
1980 Uniqueness: The Human Pursuit of Difference. New York: Plenum.

Sorenson, O.
2000 "Letting the market work for you: An evolutionary perspective on product strategy." Strategic Management Journal, 21: 577–592.

Sproull, L., and S. Kiesler
1991 Connections: New Ways of Working in the Networked Organization. Cambridge, MA: MIT Press.

Stein, J. C.
1997 "Internal capital markets and the competition for corporate resources." Journal of Finance, 52: 111–133.

Tuma, N., and M. T. Hannan
1984 Social Dynamics: Models and Methods. New York: Academic Press.

Tushman, M.
1977 "Special boundary roles in the innovation process." Administrative Science Quarterly, 22: 587–605.

Whittaker, S., and C. Sidner
1997 "E-mail overload: Exploring personal information management of e-mail." In S. Kiesler (ed.), Culture of the Internet: 277–295. Mahwah, NJ: Erlbaum.

Zander, U., and B. Kogut
1995 "Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test." Organization Science, 6: 76–92.