

UNDERSTANDING INTERACTION SEARCH BEHAVIOR IN PROFESSIONAL SOCIAL NETWORKS

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Abstract: *We present an empirical study of social interaction in a professional social network. As the point of departure, we take previous research into distributed work and information foraging theory to explore interaction search behavior of individuals active in professional networks, examining how social factors govern their behavior. For this exploration, we focused on the process through which relevant collaborators are chosen to execute shared work tasks in the area of logistics, and identified six characteristics of the explored processes. We recognized the “survival of the social” as a cornerstone for efficient and long-term professional networks and outlined design implications arising from our findings. More specifically, we found that participants are oriented to solutions that involve active social agents and social relations, rather than optimizing based on task characteristics, efficiency, and cost. These behaviors motivate the need for the concept of social interaction foraging.*

Keywords: *social interaction foraging, information foraging, social network, distributed work.*

INTRODUCTION

Distributed work (Hinds & Kiesler, 2002) is a common approach to effective collaboration. With the marriage of big professional social networks and sophisticated ICTs (information and communication technologies), organizations now can arrange effective geography-spanning work tasks. People therefore can conduct their work from remote locations or as mobile peers in these new technology-enabled forms of work. These socially organized work arrangements are better equipped for handling the dynamics of modern work settings and enhancing flexibility

in cooperation (Hutchins, 1995; Kraut, Fish, Root, & Chalfonte, 1990; Mintzberg, 1999; Schmidt, 2006; Van de Ven, Delbecq, & Koenig, 1976), but they also face a wide range of challenges. These challenges include achieving efficient coordination and task delegation without causing situations of interaction overload (Ljungberg & Sørensen, 2000), communication overflow (Ljungberg, 1996), work fragmentation, and interruptions (Czerwinski, Horvitz, & Wilhite, 2004; Hudson, Christensen, Kellogg, & Erickson, 2002; Iqbal & Horvitz, 2007; O'Conaill & Frohlich, 1995; Rouncefield, Viller, Hughes, & Rodden, 1994; Speier, Vessey, & Valacich, 2003). In order to avoid these pitfalls, it is of key importance to extend the understanding of distributed work organization and interpersonal interaction in real life contexts. Failing to address these problems will inevitably have negative effects for individuals as well as the networks to which they belong.

Workplace interaction is a phenomenon that has been a focal object of study within the areas of HCI (human-computer interaction) and CSCW (computer-supported cooperative work) for around 20 years now. During this time, the character of workplace interaction has been explored from a wide range of perspectives ranging from empirical studies of one-shot interaction (Aaronson & Carroll, 1987), serendipitous interaction (Landgren & Nulmén, 2007), casual interaction (Borning & Travers, 1991; Whittaker, Frohlich, & Daly-Jones, 1994; Whittaker, Swanson, Kucan, & Sidner, 1997), long-term social interaction (Whittaker, Jones, & Terveen, 2002), and spontaneous interaction (Lim, Zhang, Zhu, & Zheng, 2007), to studies of formal interaction (Oehlmann, Thoben, & Weber, 1997), planned interaction (Isaacs, Tang, & Morris, 1996), and structured interaction (Rogers, 1995). While this body of research has mainly focused upon the formal and informal aspects of workplace interaction, we have so far seen few studies with an explicit focus on how individuals active in these social work arrangements go about searching for each other to establish interaction, and how social factors govern this behavior. The closest related studies address expertise location usually within organizations (McDonald & Ackerman, 2000; Zhang & Ackerman, 2005), but it is likely that individuals' level of expertise is only one of the factors influencing the decision about who to establish contact with.

Our main focus in this paper is on *social interaction search behavior*, that is, how individuals search for each other in social networks with the goal of establishing interaction for executing collaborative work. We also are interested in developing an understanding of how the social dimensions of work in professional networks affect this behavior. Current theories and concepts for describing and understanding individual search behavior seem to take the individual, and not social networks, as the focal point of departure. Furthermore, we are interested in exploring the extent to which information foraging theory (Pirolli & Card, 1995, 1999), a theory typically focused on search behavior of individuals, might be helpful in this analysis. Information foraging theory has been used extensively in the areas of HCI and CSCW. It overlaps considerably with theories and models for describing and understanding information search behavior in library science and information science (Ellis, 1989, 1993; Kuhlthau, 1993; Marchionini, 1995; Meho & Tibbo, 2003). Our choice of information foraging theory for our exploration was based primarily on the previous use of the theory within the network development research community, and the fact that social dimensions were included in early work on foraging theory (see Giraldeau & Caraco, 2000). We do, however, acknowledge that other theories and models from the library science and information science communities might have been used in our exploration. We are aware as well of the fact that searching for

information might be characteristically distinct from searching for people, and that it might seem controversial to apply concepts from one area to an intuitively different problem. At the same time, transdisciplinary studies might add important new perspectives to further understanding of the object of study, in the same way that foraging theory (Stephens & Krebs, 1986), with its roots in behavioral ecology, once did for extending understanding of the information search behavior of human beings. Given this point of departure, we take information foraging theory as one source of influence, while simultaneously acknowledging previous and current research on this topic within other areas and disciplines. Vast amounts of research also have been assigned to explorations of social networks and information sharing among actors (e.g., Barabási, 2002; Granovetter, 1973; Scott, 2000; Wasserman & Faust, 1994) and, within the area of CSCW, the framework of distributed cognition (Hutchins, 1990, 1995; Hutchins & Hazlehurst, 1992) has proved to be a powerful theory for providing descriptions of interactional processes in smoothly functioning sociotechnical networks. Our exploration complements these other areas of research through an explicit focus on finding out whether the theory of information foraging can serve to illuminate precisely how individuals search for others in highly distributed professional social networks. For our empirical exploration, we targeted a communication-intensive organization called Bilfrakt.se, a logistics company for whom effective social interaction and a distributed form of work are crucial for carrying out its business.

The rest of the paper is structured as follows: First, we introduce and describe information foraging theory and current research within this area. We then present the method we used for studying social interaction search behavior, followed by a description of our empirical research site Bilfrakt.se. Having outlined our case study, we then characterize search behavior within the social network, that is, how participants go about searching for each other to establish interaction, and which factors govern their behavior. We then present six identified strategies that influence search behavior within the social network, before discussing implications for the design of social networking technologies in support of professional distributed work.

SOCIAL INTERACTION FORAGING

One of the underlying motives behind this paper is to explore to what extent information foraging theory can illuminate how search behavior processes unfold in distributed professional social networks. We first introduce information foraging theory and the problems to which it has been applied. We conclude this section by arguing for *social interaction foraging*, a new concept for describing and analyzing the interpersonal dimensions of social network maintenance.

Basic Description

Information foraging theory (Pirolli & Card, 1995, 1999) concerns how people search for information, especially on the Web. The theory is built upon the foraging constructs in human behavioral ecology (Pirolli & Card, 1995). These food foraging constructs have proven to be useful for describing the processes by which people identify relevant information, and the ways they navigate complex information spaces. But while food foraging models measure the gains in terms of energy, information foraging models do so in terms of experienced value

(Pirolli & Card, 1995). Information foraging theory attempts to understand how technologies and strategies for the seeking, gathering, and consumption of information are adapted to the flux of information around us. The theory presupposes that individuals

will modify their strategies, or modify the structure of the interface if it is malleable, in order to maximize their rate of gaining valuable information. A cognitive strategy will be superior to another if it yields more useful information per unit cost. (Pirolli & Card 1999, p. 644)

Research in different domains (which we review below) verifies the foraging model as a useful heuristic for exploring academic research and communication behavior. Sandstrom (1994, p. 415) suggested that “subsistence foragers face similar constraints and conform to the same set of principles in how they make decisions to allocate scarce resources, such as time and energy, among alternative ends in the game of survival.”

Information foraging theorists have embraced several anthropological constructs in order to conceptualize data-seeking behavior. A key concept is *scent*, which refers to the cues that information foragers use to make judgments about which information source to pursue and consume. Other important constructs are *diet* (the conscious selection of specific type of data chosen from a wide selection of data sources), *patches* (the fact that valued information is often unevenly distributed in the foragers environment), and *enrichment versus exploitation* (referring to the process through which foragers can choose to modify the context or information environment in relation to their available strategies for locating information, or start to exploit them; Pirolli, 2007; Pirolli & Card, 1999).

Previous Research on Information Foraging

Most studies of information foraging theory have investigated the usefulness of the theory or its underlying concepts for developing new access tools, improving usability, and reducing search time for Web sites (Card, Robertson, & York, 1996a, 1996b; Chi, Pirolli, & Pitkow, 2000; Pirolli, 1998; Pirolli, Card, & Van der Wege, 2000) or in large collections of text (Pirolli, 1997). One example of a new access tool informed by information foraging is the Hyperbolic Tree browser (Pirolli et al., 2000; Pirolli, Card, & Van der Wege, 2001). The Hyperbolic Tree is a “focus plus context” information visualization that was developed to increase users’ abilities to navigate complex information environments. It was designed based upon the foraging concept of *scent* and how task-relevant display cues guided the user’s visual search behavior and navigation decisions. Another example of a design influenced by information foraging is the WebBook (Card et al., 1996a, 1996b). It allows users to group together related pages on the Web and to manipulate them as a single unit. The unit is displayed using an augmented simulation in 3D graphics of a book and the use of interactive animations for indicating the relation between the pages of the book (each page of the WebBook is a Web page). By allowing users to enrich their environment, the system promotes more rapid access to information by reducing access time to different information resources. A related design is the Web Forager (Card et al., 1996a, 1996b), an application that inserts the WebBook and other objects into a hierarchical workspace. The Web Forager supports interaction with units of Web pages and enables the necessary trade-offs between screen space, number of entities or units, and fast access.

Arguing for Social Interaction Foraging

The above studies illustrate how information foraging is concerned with individual users searching and accessing information. It typically focuses on the goal or the content of an individual information search activity. It does not examine, however, the process through which people active in highly distributed professional social networks go about searching for each other for establishing and maintaining interpersonal social interaction (i.e., how they do it and which factors govern their behavior in terms of reaching out to their social peers).

Moving beyond the individual level to account for the social dimensions of work and social networking, we argue for the need to extend the level of analysis. Although information foraging behavior has provided valuable ways for understanding the information-seeking individual, new theories and concepts are needed to describe and analyze the social dimensions of interpersonal network maintenance. Accordingly, we propose social interaction foraging to work as one such concept.

Inspired by current theoretical work describing social networking in terms of coordination (Malone & Crowston, 1990, 1994), turn-taking (Sacks, Schegloff, & Jefferson, 1974; Schegloff, 2007), and common ground (Clark, 1996; Clark & Brennan, 1991), we base our proposed concept in already established theoretical frameworks for analyzing the social dimensions of networking. Our approach defines social interaction foraging as the ways in which networking individuals execute a set of strategies to search for collaborators within the social network while at the same time preserving that network. We use this new concept to analyze an empirical case characterized by its social networking practice while being geographically dispersed.

The concept of outeraction (Nardi, Whittaker, & Bradner, 2000) was introduced to describe the additional efforts of an individual to keep his or her social network functional and intact. We expected to find similar mechanisms on a social level among and within a highly distributed social network of professionals.

RESEARCH METHODS

In this section we present the data-gathering techniques we used, as well as our research site, the logistics company Bilfrakt.se. The site was a good candidate for studies of highly distributed professional social networks. Bilfrakt.se has centrally placed dispatchers and distributed drivers equipped with various communication technologies, and their work practice involves continuous social interaction on a daily basis. A quantitative study (e.g., based upon log analysis) of the frequency of these social interactions could be of interest for understanding the amount of coordination necessary to work in a highly distributed organization. In contrast, however, our focus was directed towards the nature and meaning of the searches for interaction across this distributed professional network of dispatchers and drivers. For our purposes, we just as well could have chosen a socially structured network of professionals active in another organizational domain. This case did turn out, however, to serve our purpose well, primarily due to the network's dependency on rich and frequent interaction for managing its activities.

Data Gathering and Work Organization at Bilfrakt.se

In our study of social interaction, we relied upon on-site observations and qualitative interviews. The data-gathering process was very traditional when it came to the planning and execution of the interviews and observations, but the focus of the study had a unique character in that instances of social interaction and professional networking were sought. The study started off by a visit to the site, followed by several days of observations before the interviews were arranged. Although the observations spanned only days, they gave us an initial view of the work situation and atmosphere of the logistics dispatchers, which was beneficial when creating questions for interviews.

There were five dispatchers, of whom four were interviewed (one declined to participate in the study). A dispatcher is responsible for coordinating which drivers will work on which delivery jobs. All interviews were conducted with the respondents individually, on four separate occasions in the facilities of Bilfrakt.se. One interview took place in the respondent's open-plan office and the others' were in a meeting room in the same building. All interviews were structured around the same set of questions, recorded, and later transcribed by one of the authors. Each interview lasted between 45 and 90 minutes. The aim of the interviews was to get the dispatchers' views of how they get their work done; the analysis of the gathered data was based upon the information foraging theory. Since the interviews were conducted in Swedish, all excerpts in the paper have been translated from Swedish to English by the first author. To guarantee the respondents' privacy, they were given the opportunity to read through the paper before submission. These are some examples of questions that we asked:

- How do you as a dispatcher prioritize between different customers and drivers?
- What kind of feedback do you get from a completed driving mission?
- What is the rationale behind the selection of a vehicle for a certain driving mission?

Subjects

Four dispatchers were interviewed, of whom one was female. Their ages ranged from 25 to 50; one of them had 15 years of experience as a dispatcher, whereas the others were much less experienced (2.5 to 5 years). No specific education is required for dispatchers at Bilfrakt.se, but they all had some experience from the area of logistics, some from their current employer and some from other companies. Being a dispatcher is a demanding job and, as will be shown, it is of great importance to understand the mentality and strategies of individual drivers.

Bilfrakt.se

Bilfrakt Bothnia AB (or more commonly, Bilfrakt.se, a name especially useful for on-line contacts it serves as the company's Website URL) strives to be the first choice in logistics companies in northern Sweden. The company transports a wide range of materials, ranging from gravel and industry goods to fragile consumer products and provisions.

The company has offices in Umeå, Skellefteå, and Malå, three cities located in the north of Sweden. It employs 89 workers, has an annual turnover of approximately €65 million, and is owned by 148 haulage contractors who have a total of 400 vehicles and 610 coworkers at their

disposal. There are several reasons why effective coordination and communication are essential for the success of Bilfrakt.se. First, coordinating the available vehicles is required to maximize their use, so that drivers either are delivering for a customer or are on their way to a customer. This is extremely important to achieve profitability and competitiveness. Second, logistics is a service-based, often outsourced function, and customers demand that the service works effectively, with no room for error. Third, the daily turnover in orders is very high and the range of missions is often extremely unpredictable, which results in repeated coordination efforts.

Since coordination is so important for the logistics company, the individuals involved in the processes of assigning suitable vehicles to driving missions (the dispatchers) are key players in the organization. The five dispatchers are located in an open-plan office in Umeå; their job is to coordinate all logistics activities remotely. Each dispatcher is responsible for a specific area of driving missions (except in one case, construction, where two dispatchers are needed due to the high turnover in orders). The specific mission areas are

Thermo: transportations in which the environment in the cargo space needs to be cold or warm. The dispatcher involved in this mission area is also responsible for long distance shipments of perishable provisions. Typical deliveries involve fish or flowers.

Distribution: the regular delivery of goods and provisions in the province of Västerbotten. The vehicles coordinated by this dispatcher have a specific route that they follow every day, with more or less the same cargo every time. Typical deliveries would be dairy products.

Fangio: short-range distribution of smaller goods, often with smaller trucks or pick-ups. These cars/trucks often distribute items such as additional equipment to construction sites and personal deliveries.

Construction: logistics related to construction work. These trucks distribute sand or topsoil, but also frequently work on excavation and removal of material. The nature of the work for these trucks differs from the others, not only because of what they carry, but also because they sometimes stay and work with a customer for an extended and often unpredictable period of time.

The nature of a working day varies for each dispatcher, depending on the mission area for which he/she is responsible. We are interested in exploring the character of search behavior within social networks and examining how information foraging could be helpful in this exploration. We therefore chose to focus upon the two areas of transport planning where the frequency of interaction and the need for cost-efficiency is highest, namely the areas of Fangio and construction. These areas differ from the others (distribution and thermo) in that they are dependent upon intensive communication for success. To support them in this work, dispatchers have arranged their work environments accordingly (see Figure 1).

The work environment of the Fangio and construction dispatchers is arranged to enable quick access to multiple sources of information and interaction channels. Not visible in Figure 1 are a fax machine and the dispatcher's colleagues. Mission dispatchers in both areas use a software system named CockPit (see Figure 2), although the Fangio dispatcher used an older version of the software. Such a system is used to keep track of vehicles and driving requests. A delicate matching process between driving requests and driving resources takes place as soon as a request is made. The process of finding a suitable driving resource is based

on information kept in the software system, involving information in the head of the dispatchers, as well as formal and informal procedures.



Figure 1. The work environment of a dispatcher.

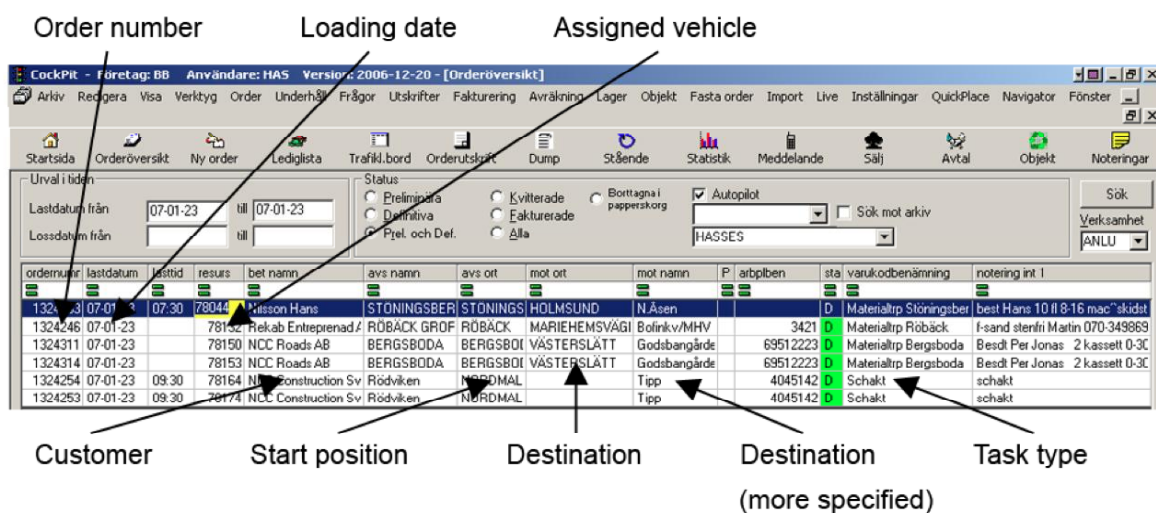


Figure 2. The CockPit interface used by construction dispatchers to keep updated on incoming requests for driving missions.

The dispatchers make use of a vehicle queue for their work (see Figure 3), in which they can see who is available and next in line to receive a driving mission. In Figure 3, the left column provides a short description of the vehicle and the second-from-the-right column lists a two-digit number describing the availability status of a driver. The code 02, for example, indicates “available, in the car.”

When a customer makes a request, often by telephone, the dispatcher stores the request in the CockPit system and assigns a vehicle from the vehicle list. The stored data includes customer name, destination, assigned vehicle, and so forth. In principle, the process dispatchers use to identify which vehicle to allocate to the next job should be obvious: They would simply look in CockPit for the first available vehicle with an appropriate specification. However, this straightforward procedure is not what they do typically. We explore why in the next section.

Umeå Bilfrakt AB, Transportledning -Foretag=Umeå Bilfrakt AB Anläggning

Arkiv Register Inställningar Orderkö Fordonskö Fordonsdata Positioner Fordon Fönster ?

Fordonskö

☒ Lediga ☐ Arbete ☐ Alla [02 = Ledig, bilen]

Fordon	Dag	Tid	Arbetad tid	Status	ID
3-axl 3-axl Trailer	01-18	11.30	0	02	78198
3-axl Rob Trailer	01-18	11.31	0	02	78120
3-axl, 3-axl Trailer	01-18	13.09	0	02	78117
3-axl Rob, Trailer	01-18	13.45	0	02	78038
3-axl Rob	01-19	16.00	0	02	78157
3-axl Rob 1-axl Slv #	01-22	09.18	0	02	78054
3-axl Kran 9,7 T/M 2-axl Slv #	01-22	12.15	0	02	78098
4-axl Dumper 2-axl Slv #	01-22	12.18	0	02	78065
3-axl, Rob Dumper 3-axl Slv**	01-22	12.45	0	02	78935
4-axl Dumper 3-axl kassett	01-22	13.12	0	02	78150
2-axl Kran Hyvelbil #	01-22	14.16	0	02	78160
3-axl Rob Lastväxlare, 2-axl s	01-22	14.30	0	02	78026
3-axl Rob Dumper, 2-axl Slv *	01-22	14.35	0	02	78186

Vehicle type Date of entry Worked time Availability status Vehicle ID

Figure 3. The vehicle queue in which the dispatcher can see the order in which vehicles should be assigned driving missions.

WORK ASSIGNMENT AT BILFRAKT.SE

In this section, we present through quotations the process of work assignment at Bilfrakt.se, a process that involves several dispatchers and numerous drivers in possession of various vehicle types. In translating to English, we attempted to remain as close to the informants' original Swedish wording, even though the spoken words at times may look odd in a written form. Occasionally, however, we added clarifying words or sentences to improve the understanding of the quotes provided. These clarifications are placed within brackets. To protect the anonymity of the construction and Fangio informants, no identifying information is attached to the quotes.

Selection of Drivers for Job Assignments

The main objective of the dispatcher is to match an available vehicle with a driving request from a customer. A construction dispatcher described the idealized process as follows (please note that he addresses himself in both first and second person in the quote):

I receive orders and then I write on a pad what the customer talks about and what account number, and so on. Then I enter an order for the respective customers. You enter account number, what he has ordered, and contact telephone number and where he wants to load and unload, the unloading location, and then you write what kind of material he wants to load since that is the basis for pricing. When you are finished with that and have chosen a vehicle then you check which vehicle is available on this [vehicle queue] list. This is the availability list; these vehicles are available, so to speak. Then it says here that this vehicle is a big vehicle: It has three axles. It varies: This one has a trailer. And then you choose the first one on the list of the ones that matches, so to speak, and then you call that vehicle and say that this and this customer wants help with this.

This is how the work assignment process should be done in principle, by matching the incoming request with the first available vehicle in the Cockpit queue. But in further probing, we found that this process is often replaced by an alternative, far more complex, procedure. Other factors related to the customer, driver, task, and circumstances affect the selection of a driver for the assignment. Although the total population of vehicles needs to be assigned jobs, as governed by formal agreements, some vehicles receive more jobs than others. One dispatcher gave the following example of how the intended assignment process is altered by circumstantial aspects, in this case the location and expected duration of the task:

Their position on the list is priority one. But then you know that this vehicle [the driver of the vehicle] lives a couple of mil [a mil is a distance of 10 kilometers] outside the city. This job, maybe it involves several hours of driving or the whole day, then you bring him in, but if it's just a load then you pass him by on the list since it will cost more money to bring him in than what he will be able to make.

To be clear: Overall, all vehicles are used by the dispatcher and are provided with jobs. The haulage contractors own Bilfrakt.se, and it would be unwise from the company's perspective to favor some contractors or to treat others unfairly. There are, however, complex factors that affect precisely which vehicle is assigned a certain request. One such factor is the identity of the requesting company:

It is nothing to put under the chair [Swedish expression meaning that it is public knowledge] that we have certain customers that we prioritize. The largest customers, you need to hold them under their arms more [i.e., provide better support] since they are such large assigners for us.

This means that a certain vehicle might be saved for the driving request of a large assigner, which in turn means that another less suitable vehicle might be assigned to other requests made by less important customers. In construction, some requests are associated with a higher risk of the vehicle getting “stuck” at the site, for example, excavation requests. Thus, the dispatcher becomes less prone to assign a rare type of vehicle to such a mission because that vehicle may be needed for assignments for which only this particular vehicle is suitable. Another factor that influences the assignment decision is the relation between certain customers and drivers: Sometimes customers notify the dispatchers that they do or do not want a certain driver to work for them.

Factors related to specific drivers also enable the dispatcher to make a successful match. Such factors include the location of a vehicle (since proximity speeds up the execution of the task and reduces the between-task time), the current status of the vehicle (drivers are able to

signal their availability from their vehicles), the estimated chances that a certain driver will accept the mission (some drivers are known for their tendency to reject driving missions during some periods), and the flexibility of a certain driver (his or her ability to take on ill-defined tasks). Flexibility is one driver characteristic that is mentioned by several dispatchers as important for the assignment of requests:

Some manage themselves, and some I know that they are skilled, and some are incredibly, well, they should have a job where they just drive from position a to position b, preferably all summer. But others are incredibly flexible and manage their own problems, [are] customer friendly and, and, of course, they exist as well.

Another important characteristic of a driver that plays into the assignment decision is whether or not the driver can work quickly. One respondent gave the following answer to the question regarding whether he knew which drivers to assign to a very time critical request:

Yes I do and you learn that really fast, how they are as a person. Some are impossible to speed up and some have that speed even if it's not necessary. It is how you are as a person. Some need more time. That is just the way it is.

Thus there are multiple reasons why the official procedure described in the beginning of this section is not followed. In fact, it is unusual for the incoming request to be directly matched with the queue list, with the first available driver allocated. Instead, other complex aspects, both human and highly contextualized, govern the matching process. There also are situations when a customer asks for not only one but several specific drivers for a job:

Sometimes the customer has had 4-5 vehicles driving on a job and then they have had a halt for a week or two and then he calls and says, "I want those two." And it can be for practical reasons or it can be equipment reasons—that their vehicles are constructed in a certain way. But it can also be a group that works very well with the excavator and the tractor and everyone.

In some situations, drivers take active part in the process of work assignment. One respondent commented,

It happens that I try to reach a driver and he turns me down and that he refers me to another driver that he knows is available. And that sometimes happens.

This useful information for the dispatcher will most likely reduce the effort spent to achieve a successful work assignment. As mentioned above, drivers sometimes reject assignments for a variety of reasons; thus, sometimes four or five phone calls have to be made before assigning a vehicle to a job. This is, of course, unfortunate that the dispatcher expends effort without being able to assign a job. Another negative byproduct is that those drivers that turn the dispatcher down are disrupted in the work they are involved in by these short conversations.

The location of a specific driver is a factor included in the decision making of dispatchers regarding to whom a job should be assigned. Dispatchers therefore have created a working environment well designed for this purpose. As depicted in Figure 1, multiple channels for interaction and numerous sources of information, such as maps, previous work assignments, and so forth, surround dispatchers in their workstations. Worth mentioning is the fact that it varies to which extent a dispatcher is aware of the exact location of a driver.

While the construction dispatchers often have a hunch based upon recent interaction or because of more longitudinal assignments, the situation is quite different for the dispatcher at Fangio, since the drivers are less stationary and more autonomous. As a consequence, it is less likely for these drivers to be able to help the dispatcher regarding the availability of others. The dispatcher does, however, have an open channel to most of the drivers, which means that when a request is assigned to a certain driver, another driver can interrupt and say that he is located at the exact position of the current request and could do it instead. As a consequence, the dispatcher at Fangio is much more dependent upon drivers to inform him about their position, thus allowing a better-informed allocation.

IDENTIFIED STRATEGIES OF SOCIAL INTERACTION FORAGING

Based upon analysis of the empirical data, we have identified a number of key strategies in the process of searching for social interaction in distributed professional social networks. We have decided to term these strategies *social interaction foraging* because they all relate to how and why the members of this highly distributed social network search for other persons within this network as part of their everyday work. To strengthen this analytical perspective of foraging, we have chosen to label the person searching for social interaction an *interaction forager*. What is worth mentioning here is that the process that we describe by our term social interaction foraging should not be confused with the behavior of individuals in other contexts where interaction could be foraged for with the sole purpose of interacting.

Reliance on Social Negotiation

When the interaction forager decides to contact another member of the social network and succeeds, a negotiation starts between the forager and this particular member. One dispatcher exemplified the negotiation procedure as follows:

They [the drivers] can argue when I distribute driving missions. They can see that they have received this and this, but this, they [the drivers] will not have time to do [those tasks] and then they can reject them. And then I see that, and usually call them and ask them why they have rejected it. "Well it's because these three things that you suggest I start with will take two hours, because there are time limits for driving missions, when it should be done, and on this [driving request] it says that I should do it within half an hour and I won't be able to do that." Either you have to say that it's not that urgent and that he can do it later or I am aware of the situation and have to look for someone else to do it.

This instance of negotiation takes place between the actors in the social network, and the outcome of this process potentially affects the relationship between the involved parties and possibly the whole social network. In order to maintain an efficient social network, it is in both parties' best interests that the negotiation satisfies both the forager as well as the network actor.

This could mean for the driver, for example, that it is worth taking on a driving mission that is less attractive in order to be able to get a more attractive one another day. Based upon the outcome of such a negotiation, the forager can estimate whether it is beneficial to keep on negotiating with a specific network actor or whether another person should be sought who is more likely to agree.

Recurring Encounters and Maintaining Relations

In a network of professional actors, the participants are likely to have been involved in numerous negotiations in the past and likely to be in more negotiations in the future. This means that all negotiations contribute to the development of a shared history among the involved parties, a history that is influential in the maintenance and economics of the social network, as well as in the domain in which the network is active. This highlights aspects such as the popularity of certain drivers due to their honesty, willingness to work, speed, and reliability. A driver's reputation is not something factual and predetermined, but rather is socially constructed between and among the different actors, over time and during episodes of negotiations. These relations are developed primarily between the interaction forager and the network actors, based upon previous interactions and negotiations, although other sources of information, for example, from actors outside the social network, can also play a role.

A Network of Competent Actors

The popularity of a specific driver relies not only upon his or her character, but also his or her actions. Drivers can provide information about their current status, the status of others, the state of a current task, or they can redefine the task they have been allocated, meaning accepting multiple tasks in combination by using complex problem solving. One of the interaction foragers in our study gave an example of how drivers take an active part in the joint activity by choosing to have their communication channel open, which affords a certain problem-solving behavior. The dispatcher explains how this works in practice:

I can call [using the radio] a car and say that there are some goods to collect at the hospital, [and to] take that when you have been to Ersboda [an area in Umeå]. But [another driver might interrupt and say], I am at the hospital right now, I can take it, and then it is settled that he takes it. This is much faster than the telephone, and the major advantage is that you can get help.

Note that this solution is achieved by social means. The forager does not know the exact location of the driver at the hospital (even if he knows that he will be there some time during the day), but another driver, by being an active social agent, provides new information to assist the forager in finding a better solution. The activity of the network actors combines with experiences from previous encounters (negotiations), statements from customers, and other sources of information. The totality of this information enables the forager to develop an understanding of the competencies of different actors, which is taken into consideration when striving for efficiency in the social network and the joint activity. On the other hand, network actors can boost in several ways their potential for being chosen by foragers during task delegation. They can build a reputation by always being accessible (i.e., carrying their cellular phones at all times) or by sharing awareness and availability information (e.g., using the code system to notify the dispatcher about their current situation). Another influential method for signaling competence is to solve tasks in the best possible way and hopefully impress the dispatcher or the customer, which might result in a situation where the customer asks for a specific driver when making future requests.

Symmetrical Relations

Another implication of recasting the network actors into a more active role is that their relation to the forager should be considered as more symmetrical than one might initially assume. This is due to the ability of the network actors to negotiate; to develop a reputation, a relationship and shared history with the interaction forager; and to take an active role in the total joint activity. Independently of a network actor's reputation, another influential factor when it comes to selecting a driver for a job is current location. A dispatcher describes how this works in practice:

It can be good to know that this vehicle is driving between our gravel 21 in Röbbäck [a location in the south of Umeå] with sand to Haga [another location in the north of Umeå], then it is possible that some customer has a load of gravel in Stödingsberget [a location in Umeå] that is located north of the town, to Teg [a location in the south of Umeå]. Then you know which route the vehicle takes and then you can call another customer and ask him if he has any loads to Teg. If he [the driver] is able to take that then it will be a return load and when we do not have that many available vehicles you have to utilize them as much as possible. Then you can call the [first] customer and ask if it is okay that the driver squeezes in a load. You have to check with the customer first so he, he [the driver] will be a little bit delayed. Most of the times this is not a problem; it might instead benefit the customer next time.

As a consequence, it is beneficial for a driver to keep the dispatcher updated on his or her position. The only way to do this is through interaction, either by informing or by being frequently engaged in work-related communication, such as negotiations with the dispatcher.

Network Maintenance

All involved actors benefit when the network is kept intact. The dispatcher at Bilfrakt.se must delegate tasks to all involved actors within the network: Failing to do so will likely cause disturbance and potentially might reduce the overall capacity of the enterprise because more peripheral network actors are likely to drop out. It is easy to imagine how some network actors are less attractive for an interaction forager during certain periods, but failing to delegate the tasks during those periods could be devastating in other times. Based upon the study at Bilfrakt.se, it is apparent that some tasks are, by nature, tasks that most network actors are capable of fulfilling, while others are more specific and require a much more selective choice in delegating. As indicated by the following excerpt, what distinguishes these types of tasks in the logistic domain is to a high degree dependent upon the level of problem solving involved in the task execution. Active network participants set out to solve customer problems themselves:

Many times the driver notices [when at a customer site] that there is something that should be done and contacts the foreman and says that, "I have some time left so I can help you with that," something that the foreman thinks needs to be done. He [the driver] takes the initiative himself and is autonomous. On the other hand there are drivers that are not autonomous.

As described above, the dispatcher makes use of the available vehicle queue, and the instructions to the dispatchers are that they should follow this priority list. But we have also shown that this queue is not strictly followed and, in fact, it cannot be if the dispatcher wants

the logistics activity to be as effective as possible. However, if interaction foragers continually overlook some network actors, these might drop out and, as a result, the network would suffer during busier periods of time. Thus, the maintenance of the entire social network is very important for the forager to be successful in the overall social interaction foraging activity.

Commitment and the Survival of the Social

In the Bilfrakt case, the commitment between involved actors plays an important role. The interaction forager does not consume other social actors, as food is consumed in classic foraging theory. Instead, by committing themselves, drivers become temporarily less available for interaction. This marks an important difference from information foraging theory, in which the forager consumes the information found. One example of this social process occurs when dispatchers avoid assigning certain actors (who are considered to have unique competencies) to a task so as to have them available if a more important and highly prioritized task comes up. This is a situational trade-off since the dispatcher has to see to it that the resources of the social network are optimally used. Whether a task is prioritized is highly dependent upon the customer. Some customers are more important than others, which leads to their work becoming more highly valued and prioritized than that of others.

We have also discussed the issue of commitment within the social network and how some actors are viewed as more valuable than others by the dispatcher. This estimation is based upon ability to work fast, but also upon these actors' social abilities, that is, problem-solving skills, their attitude in instances of social negotiations, their routines for making themselves reachable and for signaling availability, and so forth. This suggests that what makes a single actor successful is not completely based upon his or her individual strengths or abilities, but also upon his or her social abilities. Because commitment is such an important aspect of successful participation in networks of social actors, the term *survival of the social* is very much related to its precursor, the survival of the fittest. The key to large, functioning, professional social networks is not the survival of the strongest, but is instead individuals who are skilled at understanding the interpersonal, that is, social, dimension of their actions that transpire through negotiations with peers in the network, through building symmetrical relations, through contributions to the social networks' joint history, and through commitment to the other actors and shared tasks within the group.

DESIGN IMPLICATIONS

Various technologies have been developed for construction, maintenance, and usage of cost-effective social networks in professional settings. There has been some exploration of work-related social networking in products such as the business-related social networking site LinkedIn, and in deployed prototypes such as the social bookmarking service Dogear (Millen, Feinberg, & Bernard, 2006). However, these should be considered as exceptions rather than as common technologies. In this paper, we have presented an empirical study from which we have been able to extract a set of useful concepts for understanding social interaction foraging behavior in professional social networks. This set of concepts has been extracted from the empirical data, but also contrasted with the theory of information foraging, generating important theoretical implications, in particular

about the active nature of social agents, the need for negotiation, and the long-term maintenance of social networks. These contrast with the passive view of information consumption presented in classic information foraging theory. In classic information foraging, information is first located and then consumed: In those accounts, information does not negotiate or actively make suggestions about other information that is better suited to the forager's needs.

In addition to these theoretical implications, we also have been able to arrive at some design implications. As the first, and somewhat obvious recommendation, we believe that systems designed to support social interaction foraging need to be flexible and dynamic in relation to the multithreaded nature of human social communication. In other words, such interaction technologies should support multiple, integrated, and open channels that allow for lightweight and effective negotiations for the best person for that particular job. Such technologies also need to support finding the right person to contact in terms of competence (which is in line with previous findings in the area of expertise location). However, we have also seen that expertise is not the sole determinant of driver allocation. In this context, choice is also influenced by the current location and availability of a specific driver at the time when the dispatcher needs to delegate a job. Here, we envision systems that provide information about how to reach the members of the network, as a complement to today's peer awareness systems. This might include typical buddy lists showing who is on-line in the network and their availability status. But we are also envisioning systems that support channel awareness, which could indicate the available communication channels (phone, radio) for each peer in the network.

Any technology designed to support social interaction foraging also needs to account for the social dimensions of interpersonal interaction in order to create a balanced social network. All peers need to be actively engaged in the network, and the linkages between the peers (i.e., the persons in the network) need to be strong in terms of frequent short-term interactions. They also need a common understanding of the task at hand, while at the same time ensuring that the network is working at an acceptable level of effectiveness. This includes the building and maintenance of trust, reputation, and division of labor, which is a recommendation related to the ongoing process of social negotiations within the network. Here, interaction technologies in support of social interaction foraging behavior should support the forager in his/her making of individual annotations about actions and interactions within the network to help maintain a history of activity. However, we do not advocate that the activity notations be widely distributed within the network because some network actors may lack a common understanding of the history of the social network and could easily misinterpret such information.

Second, we can see how technologies to support social interaction foraging should include functionality to provide some selected users with overviews of social network interaction histories (similar to the work done on e.g., ContactMap, Whittaker et. al, 2004; RoamWare, Wiberg, 2001; or Themail, Viégas, Golder, & Donath, 2006) but also complemented by information related to agreements and allocations of shared resources (e.g., an overview of a person's commitments and what peers in the network have committed to that person). Even though these options might be beneficial in relation to our theory of social interaction foraging, we do note, on the other hand, that such technical support would need to be carefully implemented to avoid becoming unwieldy. Still, we view this recommendation as tightly coupled with the issue of transparent commitments among the peers who constitute the social network.

However, designers of technologies to support social interaction foraging need to consider a couple of paradoxes related to these design recommendation. The first paradox is how to

support an equal distribution of work among the peers in the network to make sure that everybody is actively involved while, at the same time, making sure that work is carried out as effectively as possible (Karau & Williams, 1993). The second paradox concerns the fact that most social interaction foraging is informal and highly dynamic; clumsy attempts to computerize this interpersonal interaction might compromise these critical features. We do not wish to impose a more formal, explicit routine for making prioritizations and achieving divisions of labor within the social network, which also might lead to an overly heavyweight articulation of work. This is a complex question for any designer of social interaction foraging technologies, but we have taken the individual interaction forager as our point of departure in computer support instead of technical solutions for shared views on individual social interaction foraging behavior. By supporting individual foraging behavior, we seek to promote stronger social networks, rather than trying to support the complete network as one intact unit. The latter goal risks over-formalizing the currently informal social interaction practices.

DISCUSSION

In this paper we presented social interaction foraging as a guiding concept for understanding everyday social interaction within highly distributed professional networks. This understanding is fundamental for supporting networks of collaborating actors with the tools and procedures that are needed to achieve coordination across distance, without creating escalating levels of various forms of overloads (Farhoomand & Drury, 2002; Hancock et al., 2009; Ljungberg & Sørensen, 2000), work fragmentation, and interruptions (Czerwinski et al., 2004; Hudson et al., 2002; Iqbal & Horvitz, 2007; Speier et al., 2003). Even though this new concept has some relations to previous research on social foraging, we want to clarify that social interaction foraging does not refer to the joint collective foraging process as it is described in Giraldeau and Caraco (2000), nor the joint social searching for information as in Chi and Pirolli (2006). Rather social interaction foraging in our research provides a perspective for how people identify resources in a social setting where they have to identify various people for work allocation. From the individual dispatcher's perspective it involves the process of creating and maintaining efficient forms and structures for effective social interaction. In terms of (cost-) effective social interaction, there have been some studies on the computerization of manual routines (Iacono & Kling, 1996), primarily focused on office automatization. A related area concerns maintenance of social relations at the individual level, that is, contact management (Nardi et al., 2002; Whittaker et al., 2004; Whittaker et al., 2002). There is, however, little research related to social interaction search behavior within highly distributed social networks. Our view is closely related to work concerning expertise location (McDonald & Ackerman, 2000; Zhang & Ackerman, 2005), even though we acknowledge that there are also differences. For example, one thing that has not been discussed in the expertise location literature is the long-term aspect of maintaining a relationship with an expert. We are interested in developing a more detailed understanding of the social mechanisms that enable and control the interplay between the actors in large professional social networks, instead of taking the perspective of a social group as a unit and its foraging behavior in relation to an isolated piece of information. Work moving in our direction is, for example, Harr and Kaptelinin's (2007) research on the influence of social factors on effects of and strategies for managing interruptions, even if the scope of that work is much more narrow than this.

To summarize our efforts, we applied information foraging theory to a new domain. We found that dispatchers engaged in social foraging develop relationships with the drivers, and thus a model of negotiation as opposed to consumption was more appropriate. Drivers might refuse missions, recommend others for them, or actively suggest that they could take on a new job. In turn, dispatchers built up a nuanced picture of the capabilities of different drivers and made their choices for work allocation based on this information. Future work needs to extend these initial concepts and develop new technologies to support them better.

CONCLUSIONS

We presented in this paper an empirical study of social interaction foraging behavior in a highly distributed professional social network. We showed that social interaction foraging behavior can best be described as an ongoing process of social negotiation rather than one-shot information consumption, as well as the importance of recognizing this process in terms of recurring encounters. We also advocated a move from viewing other network participants as containers of information to competent actors who contribute to successful problem resolution. These are fundamental divergences from classic information foraging behavior. As such, social interaction foraging contains aspects of cultivation that is preparatory work needed in order to promote efficient social interaction search behavior at a later stage. This notion is similar to what Nardi et al. (2000) termed *outeraction*, even if their focus is on a specific technology (instant messaging) and not on interaction search behavior in professional networks in general. To some degree this aspect of cultivation is also covered in information foraging, that is, in the enrichment versus exploitation concept but, as previously mentioned, not with a focus on social activities, and not in order to prepare for the establishment of interaction.

Our study contributes important findings leading to extensions of information foraging to social settings. Furthermore, we identified and acknowledged that functioning social interaction foraging behavior builds upon symmetrical relations, a shared view of the importance of network maintenance, and a strong commitment towards each other and towards the tasks that need to be carried out by the group. Given our extended perspective, we also identified the survival of the social as a central cornerstone for any efficient and long-term professional social network. Finally, we identified and outlined some design implications in relation to our findings, and contrasted our results to previous research regarding social foraging theory. Our future research on this topic will include further analysis of social interaction foraging behavior, the construction and validation of models to describe the relations between the concepts identified and design, and evaluations of prototype systems specifically designed to support social interaction foraging in highly distributed professional social networks.

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