SIREN: Mediated Informal Communication for Serendipity

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***Abstract*—The process of education and innovation often involves individuals, whose expertise lies in diverse fields. Informal communication amongst them can prove to be invaluable towards their collaboration, but rarely does it extend beyond one's already established social circle. This paper proposes SIREN, a system, which makes use of sensor nodes to detect encounters between colleagues in their workplace, as they undertake their daily tasks and spreads information virally from one to another. The aim is to introduce a channel of informal communication that is not disruptive to their routine. We developed a system prototype and conducted a field test to detemine whether the premise of encounter-based information sharing offers any added value over information sharing without discrimenation, amongst users in the same work setting. The results indicate that SIREN can help break down barriers and promote subsequent direct communication between users.**

***Keywords*-human-centered computing; wireless sensor networks; serendipity**

I. INTRODUCTION

Large organizations operating in campus settings, such as universities, tend to bring together people from a variety of backgrounds, to contribute their expertise to the challenges that education and innovation present. Characteristic of the affordances allowed by this environment is Humboldt's vision of teachers and students, not merely engaging in the tutoring and learning processes, but also taking initiatives in the investigation of their own research interests. In his 'Theory of Human Education', Humboldt stresses the importance of the links established between the individual and his/her surroundings for the fulfillment of such a purpose [20].

There is strong support for the importance of informal communication in the establishment of such links. Informality here, refers to the attributes of spontaneity and richness, beyond the impositions of rules and hierarchies and the lack of pre-specification [27]. It is also strongly associated with face-to-face communication. This kind of communication has been found to often constitute the beginnings of scientific collaborations, as reviewed in [24][28]. Additionally, the feeling of community and familiarity that is often implicit in informal communication plays a decisive role in how gratifying the working environment can be, and is considered a necessity for innovation [14]. Kraut, Egido, and Galegher [26] found that through informal communication, collaborative relationships between scientific workers were established.

Corridors and collection points such as elevator lobbies and support services (e.g., printers, water coolers, coffee stations) have been found to be instrumental in promoting informal communication. However, factors such as the dispersion of workers behind physical barriers (doors, stairs, corridors), the lack of acquaintance with others, unaligned schedules and the need to observe hierarchy, tend to discourage informal encounters, or take away from their potential, when they take place. As pointed out by Serrato and Wineman [33], Allen [1] advocates placing support facilities so that they are shared by workers, whose physical separation might otherwise inhibit communication.

Given the importance of informal communication between colleagues, a vast array of technologies are available, which can help distributed coworkers overcome physical barriers and can also facilitate contact and foster collaboration. These range from landlines and mobile phones to video and audio teleconferencing, from voicemail to email and mailing lists, and from instant messaging to wikis and personal blogs. A recent survey [12] indicates a massive dominance of tools that actively transmit data to recipients found in a list of contacts (email, instant messaging) over media that passively allow for potential public access, such as wikis or blogs. Eventually, dissemination of information through a network of contacts, is bounded by the extent of one's contact list. Moreover, these tools operate under the assumption that people work solely at their desks, completely disregarding a user's physical environment.

To address these shortcomings, we examine in this work the numerous chance encounters that take place in the physical setting of an organization, in this case a University. We consider chance encounters to be the unintended meetings of people, who are either familiar or unfamiliar with each other. They take place not only between established collaborators or socially involved colleagues, but also between plain acquaintances, non-strangers or even total strangers. Chance encounters are valuable in themselves when they cause people to strike conversations, but this happens only rarely. Still, due to their episodic nature and the fact that they are

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situated within the physical space, they carry high potential for allowing an individual to attain both an implicit awareness and an explicit knowledge of what activities, questions and findings their co-workers are concerned with. Furthermore, they can become the basis for the establishment of channels of informal communication.

To this end, we introduce a platform that attempts to embed the individual into an informal, ad hoc social network where information is shared virally amongst peers, who physically encounter each other in the same work setting, specifically that of a university, with the purpose of inducing serendipity in information exchange for its users. Viral sharing, in the context of physical encounters, refers to the ability of a user to transmit, upon an encounter with another user, information, which has previously been picked up from a different person not involved in the current encounter. Serendipity refers to the happy accident. or otherwise, the beneficial outcome that is potentially latent in these accidental encounters.

In the text that follows we first look at related work that has been conducted in the past. We then lay out our concept and present the platform, an application for it and a field evaluation of the system, juxtaposed with a similar application lacking the premise of physical encounters and the viral dimension.

II. Related Work

A multitude of systems for information sharing or creating awareness have been proposed, with the intention to support informal communication amongst physically dispersed co-workers. Here we choose to discuss those, which we consider to be representative of the tendencies in development. They fall into two main categories :

a media spaces that make use of video and audio to compensate for distance, by creating a virtual shared space, either through videoconferencing or virtual environments. Such applications encourage serendipity by attempting to facilitate informal, accidental encounters between people who would not have that chance in the physical space (tele-proximity).

b applications that have actual physical proximity at the basis of their operation. Given that individuals find themselves within close range of each other, they try to detect these events and provide awareness.

The systems in the first category, when compared against actual physical proximity, allow for some of the latter's most inherent properties to surface. They help illustrate, both by their shortcomings in relation to physical proximity, and their successful substitutions of it, the desirable properties that are inherent in physical interaction and indicate how some could be substituted. In a similar manner, systems in the second category also carry lessons to learn.

Cruiser [30], in 1988 and VideoWindow [16], in 1990, attempted to create artificial proximity in order to support informal communication. Citing co-presence, low personal cost and the concentration of a population of suitable partners as some of the characteristics of physical proximity, the systems tried to leverage audio and video in a unique system. The resulting virtual workplace was supposed to recreate those characteristics and increase the number of potential interactions between coworkers at different locations. It was found that it could not fully account for the merits of actual physical co-presence.

EuroPARC's RAVE system [17] also aimed to support both synchronous collaboration and semi-synchronous awareness amongst physically separated colleagues, by means of audio and video. RAVE considers the general awareness it facilitates to be the underlying foundation that can lead to serendipitous communication and even to focused collaboration.

The Forum Contact Space [23] was another such system, which intended to provide colleagues with a Collaborative Virtual Environment, where chance encounters could take place. To produce these, the concept of Symbolic Acting is employed, where real activity on a desktop computer is mapped onto a state in a virtual world. The authors indicate that online unintended interactions helped lead to real world interactions and develop a feeling of community.

On creating awareness when physical proximity occurs, one of the first studies, in 1992, involved the ActiveBadge [36], a technology first developed for the purpose of providing a central service with information about the location of individuals within a building. The badges could be detected by special sensors placed in areas of interest and inferences could be made not only about a person's whereabouts and how to accurately reach them at that point in time, but also about the people they were with at that given moment.

As early as 1996, Bly and Belloti describe a change of focus in research and design of Computer Supported Collaborative Work (CSCW), from substituting for mobility in informal communication, to supporting its role [2]. However, their proposals were limited to allowing users to be away from their desks without experiencing the negative aspects of wandering around the corridor (e.g., missing important messages and phonecalls). Although their proposals acknowledge the importance of informal communication in corridors and common areas, their systems only at a rudimentary level allowed this and did not facilitate these activities. In a later paper the authors also provide an extensive overview of difficulties in media space designs [11].

MemeTags [5], in 1998, based on ThinkingTags [6] and GroupWear [4], looked into offering conference attendees a tool to promote interaction between them through the exchange of preselected short messages (memes). The exchange would happen by means of electronic badges with an LCD display and infrared communications. Upon facing each other, they would exchange memes and prompt the user to indicate agreement or disagreement. Thus, conference participants could build a shared understanding and lay the ground for future collaboration. Large displays (community mirrors) dispersed through the conference would also let people have an overview of the most agreeable memes and the general activities within the system.

HummingBird [21] introduced the term 'Interpersonal Awareness Devices (IPADS)'. It describes those devices,

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which aim to help people initiate contact, rather than sustain the actual communication, and do not rely on any additional infrastructure besides their own kind. HummingBird alerts people by aural and visual means when they are in the vicinity of each other. HummingBird showed more potential when used in unfamiliar situations, such as trips and conferences, and was mostly ignored in the office setting.

ProxyLady [9] uses PDAs equipped with radio transceivers, with the objective of fostering face-to-face communication. The user associates information items with people (candidates for interaction). When a candidate is near, the PDA notifies the user and brings up the associated information item. The implications of this association is that exchanges only happen between users who have already been in some form of contact with each other. Contrary to Hummingbird, which seeks to maintain general awareness in (mobile) groups, ProxyLady aims to increase the frequency and quality of opportunistic, informal communication.

Hocman [15], in 2004, focused on the particular case of motorcyclists. It offered users own control over what they shared in the system, a feature that GroupWear and Hummingbird were lacking. It provided motorcyclists equipped with PDAs while driving, the capability of sharing html pages, audio files and images with other bikers who were also in possession of a PDA and had been in their vicinity. A sound clip was played when another rider was close. A field test found that the bikers appreciated hearing the sound clip, inspecting logs, and browsing contact information. However, they did not believe that Hocman would rationalize biking. The prototype was also found to support the possibilities for further contact.

Social Serendipity[13], in 2005, used profile matching to alert users that possibly interesting people have been found in their proximity. It relied on bluetooth devices to detect encounters and in later iterations also allows users to share their profiles.

All of the above systems have had positive results to report in certain respects, which justifies the notion that there are desirable properties to the sharing of information on the basis of physical proximity. They are quite different from systems aiming to support co-workers in remote locations. The concept we present, which we call SIREN, combines aspects found in the former systems with unique characteristics, for a particular cast of users. In particular :

- SIREN, much like some of the systems discussed, uses the basic concept of information exchange based on proximity.
- It is different from similar systems in that it makes no effort to alert or interrupt users in any way, at the time when the encounters are sensed.
- It also, for the first time, introduces the concept of transmitting received information to others according to a viral model, without the user's initiative.
- SIREN targets members of a university community, where sharing and combining knowledge from different fields is always desirable.

The following paragraphs outline SIREN and detail the design, implementation and evaluation of a prototype that puts the concept into effect.

III. The SIREN concept

SIREN stands for Serendipitous Information-Relaying ENcounters. Encounters between users are the key premise of the system's operation, and serendipity best illustrates the desired effect for the system.

Our concept builds upon three central notions :

A. Physical encounters

Information is exchanged between two users when they find themselves in each other's close vicinity. Users become the routers of the information they carry around. The network paths, which information is routed along, are woven into the physical space users move around in. These encounters happen naturally and accidentally as people move about in their workplace. They can be however unsuspected or brief and the exchange does not require that they become actual interactions or conversations.

From a Human-Computer Interaction perspective, most of these encounters are not meant to interact with the system. Nonetheless, they are sensed and understood by it as input and make up the fragments of situational context for implicit human-computer interaction, as defined in [32]. The implications of looking at physical encounters in terms of implicit input become apparent later, as we separate the concept into two distinct levels, the platform that acquires this information and the application that makes use of it.

Additionally, a significant number of these encounters are part of an individual's episodic personal history [35]. The pieces of information received through them, compared with the features that define the sharing incident (spatial setting, temporal data or data about the origin of the information piece) can lead to semantic encoding of those encounters [35](p. 398).

B. Viral transmission

A single piece of information can be transmitted from carrier to host, rendering the latter into an infectious agent as well, mimicking the way a virus spreads over a population.

Traditionally, information flows selectively, passed on by its host only to contacts that the host thinks it would be of interest to. In addition to this, the principle of homophily tells us that people with similar characteristics tend to network with each other [37]. McPherson, Smith-Lovin and Cook state that 'Homophily limits people's social worlds in a way that has powerful implications for the information they receive, the attitudes they form and the interactions they experience'. [29].

In contrast to this, the viral transmission model promotes the far-reaching capabilities of sharing information with SIREN. It engages unrelated users, who do not encounter each other, into transitive relations amongst them and their common intermediate contacts(Fig. 1). It also helps provide a by-product awareness of the state of interactions within the system and the

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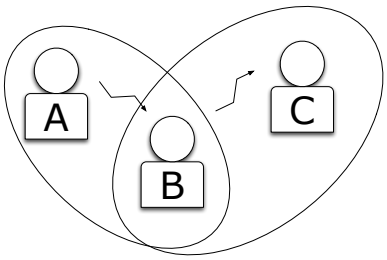

Fig. 1. With viral sharing, A and C enter into a relationship of exchange because of their individual connections to B.

workplace, one which, as described in [34] is not purposefully declared, but unintentionally arises from the plain fact that the history and current state of the system are such.

C. Seeding and viewing of information

User interaction with the system and the information that is transmitted through it need not take place at the level of encounters. The use of an application to load information onto the system and to view information that has been received is still necessary, but only at the user's choosing. The technology itself is not meant to be disruptive to the user's routine and need not demand their attention.

D. Mode of operation and the intended effect

To further elaborate, in our proposed system, users are cast in the role of information carriers and the system attempts to distribute this information from one to another, when they encounter each other as they move around. Once two users are found to be within close range of one another, an encounter is registered and pieces of information they carry are exchanged between them. The exchange takes place effortlessly, not requiring the user's intent or attention. The role of carrier need not be limited to human agents, but can also be assigned to specific objects or locations, such as coffee machines and common rooms, thereby rendering them collectors and hotspots of information. A single piece of information, once picked up by a carrier, joins the pool of pieces of information, which that carrier can transmit, and can be then retransmitted to another one, following a model of viral transmission.

Consequently, a particular piece of information can reach a far greater number of users than traditional personal exchange or contact-list based communication tools (email, instant messaging) could allow for [37]. Moreover, a very diverse network of information flow can be formed, taking advantage not only of the ties between users (strong and weak [19]), but also of elements in their mutual physical surroundings. It is out of the concept's scope to dictate the nature of that information.

The effect that we desire the system to have, in its setting of use, is best illustrated by the concept of serendipity. Serendipity already holds a prominent place in the discussion for creativity and innovation and numerous findings have been attributed to it in science and technology [31]. Nowadays [18] it describes the unsought-for finding that has value. It is also associated with the human faculty of making the finding, or seeing the value or benefit in the fortuitous event. Serendipity is thus the beneficial or happy accident and while we cannot account for the human ability to draw insight from incongruousness, we aspire in providing our users with the accidental findings that they can potentially benefit from. Those findings can either be the information that is shared, or come from the knowledge of the (potentially viral) path that it took to reach the user and the assumptions that might be made about its carriers.

IV. Prototyping SIREN

In designing a prototype of the SIREN concept, we set out to target the workers of the Main Building of our University . We define the goal of the prototype to be to 'Support education and innovation using serendipity, for users in the Main Building'.

The Main Building is one of the largest buildings on campus and home to two different departments. Administrative staff, students (undergraduates and graduates) and professors share the building and its neighbouring cafeteria.

A. Problem domain analysis

A gathering of requirements took place at the beginning, which consisted of 3 steps: a focus group, interviews, and an online questionnaire.

1) Focus Group: The focus group was put together for the purpose of testing the concept's validity with the intended users and also to identify concerns they might face when using the system. It consisted of 7 students from mixed educational backgrounds, who were shown a video prototype outlining the core concepts of information sharing based on physical proximity and viral spreading of that information. They were then asked to individually consider a list of aspects that had not been addressed by the video prototype and possible implementation opportunities.

Results of their individual reflections were addressed in a consequent group discussion. Afterwards, they were transcribed to a hierarchy, by concept and by aspects that we asked them to think about. This gave us an overview of current issues and concerns, detailed in Table 1.

Notably, the focus group identified the social potential of informal knowledge sharing. More particularly, it was reported that hinting at information can be more powerful than its exhaustive provision, in the way that it stimulates curiosity and discussion.

2) Interviews: A set of interviews were conducted with students, postgraduates and professors from two different faculties, both placed in the Main Building. The purpose was to find out how informal communication takes place amongst our potential users and what their attitudes towards information and knowledge sharing are.

The total interviewees were 15. They were all asked 6 questions in a semi-structured way and the answers were analyzed using open coding. Besides gathering qualitative data,

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TABLE I
FOCUS GROUP RESULTS

Current Issues
Desk proximity determines degree of communication. Not enough information sharing in current practice. People are protective of information regarding their activities or concerns.
Application concerns
Too much unfiltered information may lead to ignoring everything. Reyling on a device in order to share information could make you less social.
Other Comments
Different sharing intent for different colleagues. Incompleteness of information might make people curious and lead to further communication.

the interviews were aimed at identifying common answers that could be used in the larger-scale survey that was to follow.

The interviews indicated that informal communication is both desirable and sought after, through a variety of means. Besides face-to-face communication, posters placed in corridors are used to communicate what people are working on. Additionally, a person's social network also plays a role in conveying information about people that do not necessarily belong to that network.

Another noteworthy finding was the interchangeable role of knowledge sharing as both an objective in itself and a pretext for communication. People do communicate with the purpose of sharing knowledge with each other on a particular topic. However, they also structure wider aspects of socializing around the sharing of knowledge and sometimes this exchange is the guise under which broader social communication takes place.

3) Online Survey: An online questionnaire was filled out by 31 respondents, all academic personnel with the exception of one. While they belonged to the same faculty, they were affiliated with different sub-departments. The survey focused on issues of information sharing, namely what the need and motivation for it could be, what kind of information is shared, in which ways, and how physical barriers affect the process.

The information that respondents mostly seek out about others is what they are working on, especially if it might be relative to their own field of research. Their methods of gathering information run from informal to formal, becoming more formal as physical distance increases between them. They also reported lower awareness about what others are working on, as physical distance of their respective workplaces increases. Although their desire to know decreases with distance, half of the respondents reported that they would still like to know what colleagues who are situated at a distance are working on.

The resulting prototype was implemented in two separate components :

1) A platform that allows the encounters to be detected and recorded
2) An application that puts the information about the encounters to use, in order to make inferences about the viral sharing of information. It also enables the users to author information, view information that they receive and further the exchange with contacts that have already been sensed.

The prototype was evaluated in a field study and was compared to an automatic way of sharing using only the web application. Both quantitative (log-files of the systems, survey) and qualitative (open-ended items from the survey and a brief interview) data was collected and analyzed.

B. Encounter sensing platform

In the current implementation of our concept, we used sensor node devices, also known as motes, and put them into service as smart badges. We used the Crossbow Mica2dot model [8], which employs an Atmel ATmega128L microcontroller and the CC1000 RF Transceiver [7], packed in the form factor of a 25mm in diameter disk. The device also features an antenna of 8.12cm and a holster for its 3V button cell battery. It is small enough for the user to carry around on their person, and meant to be used in this way. It should be noted that wireless connections implemented with these devices are very unstable. Jea and Srivastava [22] investigate some of the characterics of packet transmission with the Mica2Dot motes.

Due to device limitations no actual information, which users might choose to share, is stored on the mote itself. Instead, each mote acts as a beacon, regularly transmitting an id number (every second). Also, each mote samples an internal stack of received ids at a constant rate, checking if reception of beacon messages from other motes has taken place within a predefined time period (every 5 seconds). If that is the case, it registers an encounter along with a timestamp from its own clock. The motes are set to broadcast in low power, thus having a limited range of 3-7 meters. Consequently, the reception of a mote's id by another is considered to be indicative of the fact that their respective carriers have found themselves in the close vicinity of each other and have had an encounter.

Since these beacons cannot communicate with any other networking infrastructure (e.g., wifi nodes), a second class of motes act as intermediates and along with PCs they are connected to, form gateways to a database server. Upon encounter with the user-motes, these gateways retrieve the list of encounters from the users device and upload it to the server. The server stores each encounter, converts the timestamps that where local to each mote into the actual time and makes these data available for use by any application. Applications should then be able to deduce which information shared by one person should be made available to another.

C. Messaging application

The application implemented on top of this platform, was a messaging application. In its simplest form, it is straightforward to implement and users can readily understand how to use it. We chose the application to be web-based rather than run on each desktop. This allowed it to be multi-platform, lessened the weight of technical support requests from the users and allowed easy and central monitoring of each user's

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status. The application design also takes Kortuem & Segall's design principles for wearable communities [25] into account.

Users post textual messages, which are kept in a database. Once an encounter has been reported, the messages posted by one user become available for viewing to the user encountered. Additionally, the messages that each of these users have previously 'picked up' in the same way from other users, become available to their current encounter. In this way the viral transmission takes place.

The overview of what exchanges have taken place is available to the users from the web application, with the emphasis on the display of the text messages themselves, rather than visualization of data. Users are able to:

- Set up a profile and upload a picture.
- Write an initial message, that is a message that is being distributed by the device. The messages can be replied to and constitute starting points for discussion threads.
- Reply to a message, which no longer needs the device in order to be spread. This creates a thread based on the initial message. Replies are visible both to the author of the initial message, and to persons that have also reacted to that message.
- Follow a message, which makes the thread initiated by that message available to the users, without requiring their participation.
- Post invitations to other users to meet for a coffee.

Along with each message, information is also provided to the reader about the author of the message, the time of its posting, and in the case of initial messages, the time of reception through the wireless device.

V. Field Test

The purpose of the study was to perform an exploratory, formative evaluation and to collect ecologically valid data. Specifically, we aimed to:

- Evaluate the experience of using the system.
- Investigate whether physical encounters provide value as the premise for serendipity, over the exchange of messages between randomly selected individuals.
- Test the assumption that the viral spreading of messages effectively increases exposure to unexpected information.

A between-subjects design was used. Users situated in the Main Building where invited to participate both through a recruitment campaign, involving posters and mass-mail invitations, and through our social network.

The final sample of subjects was comprised of bachelor's, master's, and PhD students, as well as academic and managerial staff. The fact that individuals from 2 different departments were chosen, their workplaces positioned in different rooms and floors, further ensured the diversity and dispersion of the participant population. Finally, the participants were assigned to one of two conditions.

1) Using a system where sharing was based on physical co-location (encounter based sharing) with the participation of 15 users.
2) Using a very similar system that lacked any premise for information exchange other than users posting that information. Every exchange would take place between individuals selected randomly from the user population (random sharing). This group consisted of 11 users.

To isolate the effect of encounter-based sharing on the experience of the system's usage, the number of messages that would be received by users in the random sharing group was regulated to match the number of messages that were actually being received by users in the encounter-based sharing group. It could therefore be ensured that the level of usage, a well-known factor in the success of any type of social media, would not be a confounding element in the comparisons made.

After a short briefing and consent process all participants received training, where all the functions of the web application were explained. The encounter-based group received additional instructions on how to handle the motes. Participants in the random-sharing were asked to use the web application, and those in the encounter-based group to use the web application in combination with a mote. The field test lasted 5 days. At the beginning of each day participants in the encounter-based group were expected to use a fresh battery for their wireless sensor. They were also expected to carry it with them if they left their office, and make use of the web application at least once a day. Participants in the random sharing group were also asked to use the web application at least once a day.

Because the number of gateways installed was not yet sufficient for the regular retrieval of content from the motes, we frequently toured the corridors with a mote gateway connected to a laptop and sent commands to motes found within range, to upload their data to the laptop. The laptop would then upload the information to the server. This took away from the realtime aspect of interaction between motes, as an encounter that had already happened when a subject would visit the messaging application, would not appear to have been registered, until a collection round had taken place.

At the end of the study, the participants were handed a questionnaire to measure their experience. They were also asked to provide comments in an open interview. Finally, a debriefing followed and participants were given a reward for their assistance.

VI. Results

The prototype was evaluated following the principle of triangulation on the level of multi-measures. Measures that were used are:

- Content of posts and profiles.
- Log-files of interaction with the web application.
- Scores on a post-usage survey and a brief open interview following this.

The evaluation sought to:

- See if the design objectives and purpose were fulfilled.
- Justify the approach of serendipity and encounter-based sharing by showing that the latter related to positive results.
- Seek reasons for why the approach was effective or not.

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TABLE II
MEAN SCORES FOR ENCOUNTER-BASED AND RANDOM SHARING GROUPS. BOLD INDICATES SIGNIFICANCE IN DIFFERENCE.

scale	$\bar{E}$	$\bar{R}$	$p - value$
Perceived Usefulness [10]	4.38	3.33	**0.031**
Perceived Ease of use [10]	2.8	5.27	0.228
Perceived Innovation	4.71	3.55	**0.032**
Perceived Education	4.37	3.45	**0.036**
Professional Communication	5.47	5.27	0.330
Personal Communication	5.8	4.36	**0.004**
Perceived Self Worth [3]	5	4.3	**0.036**
Potential for Connecting to others	4.19	3.15	**0.008**

A. Scales Measured

Table II lists the scales measured and the scores obtained from the post-test questionnaire. In addition to the well known scales referenced, the following scales were measured:

- Perceived Innovation
  - *I believe that possible meetings following an invite facilitate innovation.*
  - *I feel the posts exchanged facilitate innovation and idea generation.*
  - *Using the system helps me innovate.*
- Perceived Education
  - *I believe that possible meetings following an invite facilitate education.*
  - *I feel the posts exchanged enhance education.*
  - *Using the system enhances my education.*
- Personal Communication
  - *I feel it is useful to communicate on a personal level with people I normally wouldn't communicate with.*
- Professional Communication
  - *I feel it is useful to communicate on a professional level with people I normally wouldn't communicate with.*

Additionally, we measured the following on a dichotomous scale :

- Attitude toward adoption of system :
  - *Consider that you have been using a prototype. Would you like this concept to be implemented in the Main Building, assuming that it would be used by most people?*
- Experienced Serendipity
  - *I experienced something random or accidental that I am happy about or benefited from because of my participation in this study.*

Scores from the two groups, in Table II, were compared using a one-tail Mann-Whitney U test, to test the hypothesis that the encounter-based system would perform better than the random-sharing one. The encounter-based sharing group reported significantly higher perceptions on almost all counts. The only exception was on Perceived Ease of Use. Additionally, Professional vs Personal Communication indicates that encounter-based sharing provides added value for informal communication over random sharing.

On whether they had experienced serendipity, 6/15 (40%) reported yes in the encounter-based group, and only 1/11 (9%) had a positive response in the random sharing group. However, a Fischer-exact test showed this difference to not be significant, with $p = 0.093$.

On their attitude toward adoption of the system, in both groups, most subjects said that they would use the system, with 60% of subjects in the random sharing group and 92% in the encounter-based group.

B. Qualitative assessments

The open-ended questions in the questionnaire and the interview that followed, as well as the content of the messages that had been exchanged, helped provide a set of observations about the use of encounter-based sharing as opposed to random sharing. Answers to the questions were qualitatively analyzed by means of clustering key descriptions of individual responses. A similar approach was used for the qualitative analysis of the messages that had been exchanged. The following observations were made :

- Messages that had been shared in both conditions were of an informal nature.
- The messages that participants in the encounter-based group wrote seemed to be less elaborate. Users mostly posted short sentences of greeting or small information about current tasks. In this respect, the system was used more like a micro-blogging tool. Replies to these messages were also short and not promoting the perpetuation of the conversation.
- People in the random sharing group appeared to be more social, posting more meaningful messages. However, discussions in the random-sharing group had been sustained between people who already knew each other, and there were points were the discourse did resemble a forum.
- Users in the encounter-based sharing group sent out invitations to meet with others, some for the purpose of testing the feature. However, most of those invitations did lead to some form of direct communication. Users in the random sharing group barely did so.
- Users that had received information because of an encounter reported that they were more eager to view it. They also trusted the information to be relevant to them.
- Viral transmission allowed users in the encounter-based sharing group to view information from people they did not cross paths with.

VII. DISCUSSION

SIREN performed expectedly better than the random sharing condition: Towards the goal of supporting innovation and education in its deployment environment, participants in the field test reported significantly better potential in SIREN than in random sharing (as seen on table II). They also perceived the system as positively useful, in contrast to the random sharing option: Their perception of the latter's usefulness was rated at 3.3, just below neutral on the 7-point Likert scale.

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However, users of both systems were favourably inclined towards their adoption, at 60% for random sharing and at 90% for SIREN. It should be noted here that the specific workplace does not offer a forum or other communication media that might allow the personnel to informally exchange messages. There is a possibility that these results reflect the lack of such a system, especially since the random sharing system seemed to be appropriated more like a forum/BBS than the encounter-based system. A reason for this could be that recipients in the random sharing condition, as is the case in a forum, could not attribute the fact that they had received a message to any other meaningful event, other than their participation in the system.

On the contrary, in the case of SIREN, it could be argued that users were much more conscious of their role in the process of the delivery of a message to someone. Also, communication did take place between people who weren't acquainted with each other. This could explain the caution they applied in composing the messages they wrote. However, the fact that the initial information exchanged follows an encounter that did occur, can help people feel more connected and experience fewer barriers towards direct communication. Hence, subsequent physical proximity and face-to-face communication can be promoted. As we have discussed before, physical proximity builds a foundation for informal communication, a positive perception amongst co-workers and collaboration.

Despite the shorter conversations, people in the encounter-based sharing group felt eventually more open to personal communication with people they would not normally communicate with. In addition to this, they reported significantly better potential for connecting to others. Also, self worth, a moderator of intention to share knowledge [3], was also found to be significantly higher with SIREN.

Another thing to note was that users in the random sharing group perceived their system as easier to use. This can be attributed to the fact that SIREN users were given the onus of carrying around their wireless device and making sure it was operational.

Contrary to our expectations, serendipity was not significantly different between the two groups. Our explanation for this is the short timeframe that the field test took place in, so that not enough serendipitous event did take place for the SIREN group. On the other hand, given enough time, every member of both test groups will report serendipity. We expect a follow up study that will last longer and investigate the rate, rather than the simple occurence of serendipitous events, to show better results in this area.

VIII. Conclusion and Future Work

We presented a system called SIREN, which uses the premise of encounters between colleagues in the workplace to facilitate the non-disruptive exchange of information. The non-disruptive exchange is one respect in which it is different from many of similar systems already proposed. The other new element that it introduces, is that it allows for information to virally spread over the population of coworkers as they encounter each other, for the purpose of promoting its distribution. The underlying assumption is that the inherent properties of routine movement in the workplace can be taken advantage of, in order to achieve both a form of implicit input, and to also provide meaningful context to the recipient of a piece of information for the reason why it reached them. Eventually it could promote the formulation of a mental model of the fields of interest of remotely distributed colleagues and the network connections amongst them and prove supportive of informal communication.

To test the assumption that physical encounters provided added value to the exchange of information, a prototype was developed and a field test was performed to explore how SIREN might be received by its potential user population. The field test tried to isolate the effect of information exchange based on proximity, by conducting a comparison to the condition of exchange in a random fashion, without the requirement that encounters take place. The comparison also focused on aspects of usage that are relevant to the setting of a university as a place of innovation and education. Additionally, it investigated serendipity as the effect of the unsought-for discovery that could be brought about, given that the reception of information because of use of the system, could be the unsought-for event.

Despite limitations in the prototype and the short duration of the field test, overall results were positive. Encounter-based information exchange was deemed to be more supportive of informal communication and was also perceived as better for education and innovation. It should be taken into account that the field test proved not sensitive enough to evaluate the difference between the two systems in their facilitation of serendipity. Participating in the study could have resulted in serendipity by itself.

However, the study reaffirms the consensus that informal communication is desired and perceived as useful. This appears to be particularly true in the setting of an educational institution. The evaluation performed indicates that there is unharnessed potential, to explore in future work, in the way people make use of their physical settings and the chance encounters that happen within the workplace, as a means for the transitive mediation of informal communication. Future work in this area, with the use of more elaborate and reliable prototypes, could include investigations of how such a system could be integrated with current social networking applications, as well as the development of new applications that make use of the encounter-sensing platform.

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