

One LED is Enough: Catalyzing Face-to-face Interactions at Conferences with a Gentle Nudge

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ABSTRACT

Face-to-face social interactions among strangers today are becoming increasingly rare as people turn towards computer-mediated networking tools. Today's tools, however, are based on the following assumptions: increased information encourages interaction, profiles are good representations of users to other users, and computer-mediated communications prior to face-to-face meetings lead to better outcomes. This paper describes CommonTies, a gentle technological *nudge* in the form of a wearable accessory, that encourages immediate, face-to-face, organic social interactions among strangers at conferences. By not exposing any profile information, CommonTies preserves an element of mystery and enables self-disclosure of information through conversation. We evaluate our system through a field study at a three-day research conference - CSCW 2014. We find that despite our information-scarce design, users were willing to interact with strangers and 74% of the interactions initiated by CommonTies were reported as novel and useful.

Author Keywords

matchmaking; wearables; nudge; computer-mediated interactions

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI):
Miscellaneous

INTRODUCTION

Conferences are professional gatherings that enable the sharing of ideas among colleagues and peers. Ideally, conferences should be welcoming to new attendees. Striking up a conversation with a stranger, however, can be awkward or uncomfortable. Conferences also have additional factors that create barriers for interaction: large rooms of strangers with unknown group dynamics and social norms, existing social cliques, which attendees may find hard to leave or join, class distinctions for example between senior and junior researchers in an academic conference, etc. This paper

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describes CommonTies, a wearable device that encourages face-to-face interactions in networking situations like conferences and receptions.

There is a potential need for networking tools that enable face-to-face interactions. First, the increase of online interactions have made face-to-face stranger interactions less practiced and potentially awkward. Second, in existing technological systems, interactions transpire first through a mobile device or computer medium where some information display (e.g. names, contact info, profiles, photos, etc.) attempts to convey the key characteristics of a stranger while missing important social cues that are present during a face-to-face encounter. Third, systems generally assume that revealing information about matches is a requisite for encouraging an interaction, but it is unclear to what extent this is true.

Our design of CommonTies is inspired by results of several psychological works by Collins and Miller [8] and Walther [31]. Collins and Miller (and Walther) find that the act of information disclosure is nuanced, active, and intimate ("hyperpersonal") and will lead to an increase in the development and maintenance of meaningful relationships. This contrasts with impersonal, automatic, and computer-mediated information disclosure to unknown strangers that can circumvent eventual self-disclosure in conversation. In this paper, we attempt to reconcile these ideas by considering the possibility that information rich profiles may not be necessary for achieving positive matchmaking outcomes in certain pre-filtered contexts.

Our key **research contributions** in this work are:

1. We put forward the following principles for the design of social networking tools in curated contexts like conferences and describe them in the Design Section:
 - (i) preserve privacy¹ and mystery
 - (ii) minimize computer mediation in human-to-human interactions
 - (iii) easily support context, beyond proximity
 - (iv) lightweight and seamless to use
2. We implement these principles in CommonTies in the form of a small, lightweight, low-power wristband we call a *tie*. Ties have an extremely limited information display — only one LED that can glow one of six visually distinct

¹In this work, the term 'privacy' is used strictly in terms of privacy between users. Online privacy and mechanisms to secure private information is beyond the scope of this work.

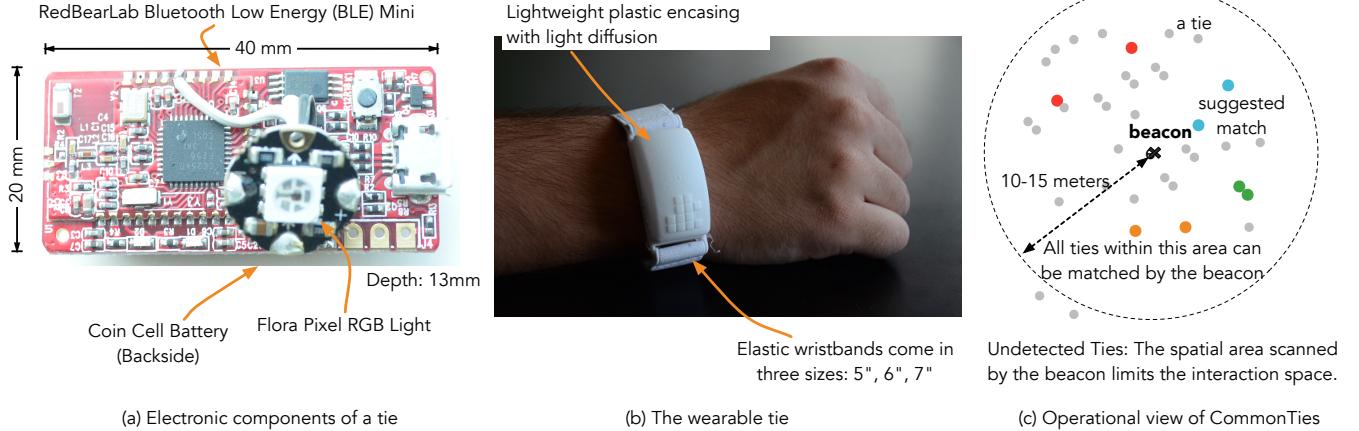


Figure 1. CommonTies - a wearable that enables social interactions among strangers via matchmaking within interaction spaces.

colors. Each user receives a tie after a registration phase that associates the tie with the user. Profiles for each user are constructed automatically from existing online social networking sites such as LinkedIn and only used internally by the CommonTies *matchmaker*. The matchmaker is an algorithm that ranks profiles of inferred strangers by similarity and *matches* their ties (glows the ties the same color) if they are detected by a *beacon*. Each beacon defines an interaction space that organizers can create according to desired objectives. We describe these implementation details in the Implementation Section.

3. We evaluate CommonTies with a field experiment at a conference (CSCW) in the Field Study Section to test whether a profile-free informationally-minimalistic nudge is capable of facilitating face-to-face interactions at conferences. Our evaluation shows that our social nudges were successful in that users actively engaged in locating matches when they noticed their ties glow. Users found their subsequent interactions novel and useful 74% of the time.

RELATED WORK

Our work touches upon a number of large research areas: networking tools, online dating, wearable devices, and “in-the-wild” evaluation. We outline the closely related works in these areas in order to contextualize our work.

Networking Tools

In the academic research space, several works use wireless devices to enable social interactions [10, 5, 4, 15]. CommonTies differs from these systems in that it is a wearable accessory that provides no information beyond a simple visual cue to initiate interactions. Unlike computationally augmented name tags by Borovoy et. al. [4] and proximity-aware mobile contact exchange applications like Serendipity [10], CommonTies preserves privacy between users by not revealing any information on match reason, match quality, or match profile.

Other works have studied the use of context-based technologies to enhance social interactions: Trainroulette [6] uses the context of a train and Mirkovic [23] utilizes technologies in

a clinic to enhance patient-physician interactions. Paulos and Goodman [26] use technology to detect the presence of “familiar strangers” [13] in public spaces. Unlike these works, our system is designed for conference-like events where attendees are pre-filtered. Also, our technology generalizes across multiple organizer designed contexts — user profiles and matchmaking criteria can be easily modified for different situations without any change to the ties themselves.

With respect to conference networking, specifically, Confer meetups [9] is most closely related to our work. In fact, we used Confer as a data source for our CSCW deployment. Confer lets users select papers they like from a conference program. Confer meetups (a special feature of Confer) suggests a list of matches to a user — other researchers who liked the same papers that the user did. The user is then given the opportunity to send an email message inviting a match to ‘meetup’ during the conference. CommonTies is different from Confer meetups in several aspects: profile sharing, interaction mechanism, and form factor. Confer meetups provides an especially interesting comparison point in the design space of conference networking tools due to these polarized differences.

Online Dating

CommonTies is different from online dating in at least three important ways. First, in a professional setting, disclosing intimate and private information is considered off limits. Our system does not solicit, use, or display such information. Second, at conferences, attendees generally seek to increase their professional networks and to discuss their thoughts on and interests in the conference’s themes. Therefore, the similarity threshold for a match can be lower than for online dating matches and attendees do not have explicit match criteria. Third, attendees at conferences may already be engaged in a conversation during a match, thus CommonTies needs to balance introducing many new interactions with avoiding unwanted interruptions. Despite these differences, the systems behind online dating and CommonTies are similar in that both provide computer mediated matchmaking with strangers.

Many mainstream and niche matchmaking services exist today to help people eventually meet each other in the real world.² Most online dating sites enable users to create and search for profiles, view matches, and provide means for computer-mediated, virtual communication through messaging, chatting, winking, liking, rating, etc., with the hopes of eventually transitioning from an online to a real-world interaction among users.

The matchmaking motivation of CommonTies is similar to online dating sites, but this is where the similarities end. Users give their email address to register with CommonTies, but do not explicitly create a profile for consumption by potential matches. Instead, a hidden profile for each user is automatically generated from online data and if the user chooses, the user's online social network is mined to bootstrap for prior acquaintances. These profiles are used internally by CommonTies and are never revealed to any user. When a match occurs, zero information about the match is given other than that they are physically nearby and glowing the same color. There is no online interaction; the only interaction possible between matches is an immediate face-to-face meeting.

Certain dating tools do allow for immediate, face-to-face interactions through smartphone integration. GPS-enabled apps notify users of potential matches in their vicinity (zoosk, badoo, grindr). However, the lack of context-awareness in such apps can leave users open to awkward encounters at inconvenient times or locations. Other dating tools attempt to minimize the amount of asynchronous, computer-mediated interaction between strangers through organized group dates or parties (meetcha, grubwithus, ignighter). Our work is thus situated within this space of physical and temporo-spatially immediate systems rather than conventional online systems. Unlike these systems, our system is not only proximity-aware, but also context aware and only functions within designated interaction spaces.

Wearable Devices

There are many projects that investigate the unique challenges and opportunities of different form factors and wearable devices for matchmaking [4, 12, 15, 19, 18]. We do not claim form factor as a contribution. However, as a result of our information-minimalistic design principle, our work is different from previous wristband matchmaking devices such as iBand [15] and Lovegety [18], which both suffered from user privacy concerns. CommonTies avoids many privacy issues by not requesting or revealing information.

In-the-Wild Evaluation

The significant differences between laboratory settings and field settings constrain the types of questions one can ask and answer. Because “laboratory studies can fail to capture many of the complexities of the situations in which the application will ultimately be placed” [28, 21], in-the-wild studies have become an accepted approach by the CHI, CSCW, and Ubicom communities [28, 22, 14].

²eHarmony, match, okcupid, shaadi, zoosk, badoo, grindr, tinder, twoo

Field studies also constrain the types of data collection instruments that may be used. Several works have investigated sensor networks in the form of body sensors or wearable badge for measuring in-situ data on social gatherings [17, 25]. We originally intended to use a similar, but less obtrusive approach to gather data on interactions. However, adding sensors to people or the ties themselves increased power, size, and other requirements beyond that of the system itself.³

DESIGN

A matchmaking system has fairly straightforward components: a profile building component, a matching algorithm that determines quality of a match between two profiles based on some metrics, and a notification mechanism. This functional description allows for many design possibilities. The most conventional of these designs is oriented toward maximizing information gathering and sharing: web or mobile applications that collect profiles and share profiles that match. From our review of the literature, we distilled the following design principles:

1. Preserve privacy, mystery, and sense of serendipity.

This design principle is a sharp contrast to the design of existing commercial matchmaking services and research projects that present a detailed profile about a person's match and the reasons for the match. Gaver et. al. introduced the notion of mystery or ambiguity as a resource for design to encourage closer personal engagement with systems [11]. By not revealing much information, we encourage a closer personal engagement with the device, maintain the suspenseful nature of meeting someone for the first time, and also allow more private individuals to decide when and how much information they wish to reveal about themselves during face-to-face interactions.

A matchmaking system should be designed to have very few, if any, predefined notions of specific interaction outcomes. Sengers et al. argue “enchanting experiences may be designed only by approaching enchantment obliquely: not by engineering it in, but by providing opportunities where it may emerge,” [30]. Our users are never told why they are matched with someone else, what they should talk about, how they should interact, or whether they must interact at all. This open-design philosophy allows interactions to be dictated by the desires of the users themselves as argued by Sengers and Gaver [29].

Finally, we do not expressly design for serendipity, but unknown elements can contribute to a feeling of serendipity. When users do not know how they are being matched, the better the match is in relation to the perceived sophistication of the algorithm, the greater the likelihood that they will feel that the match is serendipitous. For example, if the algorithm were considered purely random (as some of our participants hypothesized), then users would likely consider the match to

³We did attempt to deploy a passive sniffer based positioning system, but indoor positioning is still an active research area [16] and ours failed in the conference venue's open and crowded space.

serendipitous rather than a result of deliberate design. Conversely, if the algorithm were thought to be highly sophisticated, then even a deeply satisfying match might be attributed to the algorithm. By withholding this information from our users, we allow users to provide their own interpretation.

2. Minimize computer mediation in human-to-human interactions.

Sociologists such as Goffman and Altman describe social interactions and the development of interpersonal relationships as complex, nuanced, ritualistic, and reliant upon self-disclosure [20, 1]. We attempt to preserve these properties by minimizing the interactions that take place through a computer screen or mobile phone. This design principle has implications for all aspects of the system from registration to notification.

At registration, the information gathering interface should not force users to exhaustively specify what their profile is, their criteria for prospective matches, or the spatio-temporal conditions where matches can occur. Instead, profiles can be largely automated by relying on existing information sources or context-specific information.

Match notification should not orient users toward a screen, instead notification should occur through subtle cues in the physical world that nudge a user to find and interact with their match only when a face-to-face meeting is feasible.

Subtle nudges can also serve the dual purpose of saving face in social situations where one user is more interested in social contact than another as suggested in previous works [2, 3]. Since a subtle nudge can be easily missed, the user has a ready interpretation that the other matched person simply did not notice the match. This interpretation and the anonymity of the matched person can allow the user to maintain harmony with themselves and the match. In contrast, interactions involving asynchronous, computer-mediated communications such as messaging or email, can leave users frustrated as they wait for a response or embarrassed when their overtures are unreciprocated.

3. Support multiple contexts, beyond proximity.

Space and time collectively define the proximity where matching occurs, but context is often dependent on other factors like specific locations, situations, or conditions. Existing proximity aware systems match users based on proximity, but generally do not consider differences in context — they work the same way everywhere.

In contrast, we think interaction spaces and times should be *limited* to where and when matching is expected and is convenient. At a conference, for example, users may welcome matching during breaks and receptions, but would be bothered by matching during talks or at spaces designated for business. Furthermore, organizers who control a space should be allowed to define contexts that form the basis for a matching algorithm. At a research conference, research interests and career goals may make sense for a matching algorithm. However, at a student orientation event, hobbies and selected majors may form the basis for a more appropriate matching

algorithm. Other examples include: at a sports lounge, teams cheered; at a job fair, skills and qualifications; etc.

Finally, the context should also include the user's internal context, i.e. the user's sociability or interaction history. For example, matching should occur at a rate that does not overwhelm users or interrupt interactions currently in progress.

4. Lightweight and seamless to use.

Connected to the goal of minimizing computer mediation, but more as a matter of practical interaction design is the requirement that the device itself should be lightweight and seamless to use. The user should not be burdened with an extensive user interface.

IMPLEMENTATION

CommonTies consists of two physical components: a wearable wristband called the ‘tie’ and a ‘beacon’ that suggests matches using a profile-matching system called the ‘matchmaker’. In this section, we briefly describe the functionality of each component and gloss over the engineering details.

The Tie

We wanted our ties to have a comfortable clothing “accessory” rather than a “gadget” look and feel. Therefore, we built the tie as a limited-display lightweight wearable device to avoid screen-based, computer-like, form factors such as smartphones. We considered several different form factors including wristbands, necklaces, and conference tag accessories. We chose wristbands due to their generalizability, comfort, and style.

Each tie consists of BLE Mini chip [7] by RedBearLab [27] connected to a Flora RGB Neopixel LED v2 [24] (See Figure 1(a)). The tie is completely stateless: no system state or personal information is stored on it. We implemented our tie functionality in 500 lines of firmware code. We then designed a simple 3D printed enclosure for each tie and attached elastic straps to create wristbands of three different sizes (5”, 6”, 7”) to account for differences in wrist size. We notify users of their matches by diffusely lighting the LED with one of six distinct colors. Figure 1(b) shows an assembled tie.

The Beacon

Interaction spaces are defined as the radial area around a bluetooth base station we call the ‘beacon’. Depending on propagation characteristics of the environment, a typical beacon covers an area of roughly $300m^2$ ($3229.17 ft^2$). This means two matched ties are at most 20m apart in an interaction space (See Figure 1(c)). Larger interaction spaces can be equipped with multiple beacons for coverage.

The beacon asks the matchmaker for any matches within its interaction space. If a match exists, the beacon lights the pair of ties the same color. This is recorded in the matchmaker database and the match is not suggested again. We implemented our beacon code in approximately 800 lines of python code and wrapper functions.

The Matchmaker

The matchmaker is a profile-matching system that builds and stores user profiles, maps users to ties, and suggests matches to the beacon. User profiles are completely private and only used internally by the matchmaker. Profiles are constructed depending on the context. For example, at a conference, the organizers may decide to construct user profiles based on conference proceedings, registration information, and talks that users attend. A user at the conference will be matched based on this criteria. Later, at a reception the same user wearing the same tie may be matched based on a different user profile constructed and different matching criteria that are specified by the reception's organizers.

For the purposes of evaluating CommonTies at the CSCW conference, we implemented a single context for the conference hall. As a part of our consent form, we implemented an online registration form where users had the option to give CommonTies access to their Facebook, LinkedIn, and Confer contact lists and papers of interest through the respective APIs. Our matchmaker automatically generated each user profile from these information sources and publicly available data (like DBLP) to determine a user's friends, contacts and co-authors as well as research interests. These profiles were used by the matchmaker, but never shared with the users or their matches.

For CSCW, we chose not to attempt to engineer an ‘optimal’ matchmaking algorithm because we wanted to leave room for serendipitous matches of people who appear to have relatively little in common. After eliminating all friends, contacts and co-authors, each user had a list of strangers to match with. These pairs were ranked by a scoring function that favored interactions between strangers who (i) had higher set-similarity measures of papers liked on Confer, (ii) came from different segments of research (e.g. academia and industry), and (iii) were at different career levels (e.g. student and professor).

To avoid user fatigue from too many matches, the matchmaker only matches a person at most once every ten minutes. At any given time, at most six matches can occur as each match gets a distinct color from the set of six possible colors: red, green, blue, yellow, orange, and violet. Each tie is configured to turn off its LED after 3 minutes and we can reuse colors for another match after each interval.

FIELD STUDY

We evaluated CommonTies through a field study at CSCW in Baltimore, Maryland in February, 2014.

We decided on our eventual evaluation methodology based on several practical considerations. First, despite our advertising efforts, the attendees did not register early and we were unsure whether we would gather enough participants to give enough statistical power for definitive results; splitting our control and experimental groups apart and halving the group size would reduce the number of possible matches within each group by 75%. Second, our participants generously volunteered to commit their limited conference time to participate in our experiment. We did not wish to give a control group an artifact that could waste their valuable time,

attempt to conduct extensive interviews, or ask for lengthy survey responses. Third, the focus of our work was not the efficacy of our matchmaking algorithm, but whether a subtle nudge could catalyze interactions with strangers. Finally, we were not aware of any system evaluations in conference matchmaking that had been subject to control conditions.

One week before the conference, we elicited the participation of conference attendees through Twitter and email invitations. Participants were also recruited via passing out flyers the day prior and day of the conference. Participants could register online or at our registration booth. Ties were then distributed at our booth on a first come first serve basis.

After registration, participants were given only basic instruction on the functionality of CommonTies before being given a tie: “A glow indicates that someone is matched nearby. Go talk to the person with the same color. It will work only at social events.” If participants asked why their social media information was being requested, we informed them that we only use their friends list to avoid spurious matches. Participants were asked to return the ties at the end of the conference or when they needed to leave and to fill out a survey at that time. We did not conduct any interviews with participants during or after the conference. For the duration of the study, one or both of the two researchers manned the registration desk, wrote field notes, took photos, and made observations on how people responded to CommonTies.

We recognize the potential biases with our study, especially given that our subjects were researchers themselves, but we took several measures to minimize these issues where possible. We mention these measures here to help frame the presentation of our results. First, we had no familiarity with the CSCW community: we had neither published at nor attended CSCW before. A handful of attendees were acquaintances who did not participate in the study. Second, CSCW organizers did not help promote registration to avoid bias. Third, we refrained from discussions with participants about the ties both in terms of instruction and suggested use beyond that CommonTies was a matchmaking tool in order to avoid demand characteristics as much as possible. Throughout the study several participants asked us about the matchmaking algorithm, but they were politely told that the algorithm was a secret.

While we did collect various social network information from our participants, including demographic information, we did not attempt to store or analyze this data past the purpose of matchmaking so as not to infringe on our participants' privacy or deter participation. We instead present results from our surveys and where appropriate we corroborate our data with our server logs and discreet observations. We observed by walking through the crowd and watching matches to see how they responded (or did not respond) to the nudge. We also followed interactions through their conversations, but did not listen in on conversations. We took field notes on our observations and also some photographs.

After collection and transcription of survey data and observational notes, we collectively looked for predetermined and

emergent themes. We then discussed these major themes and organized them for presentation.

Deployment

Figure 2 illustrates the registration of participants over the course of the recruitment process. Only eight attendees registered prior to the conference online. We recruited additional participants during CSCW’s workshop days prior to the conference by setting up a registration booth and distributing information pamphlets on CommonTies. Before our first event, the welcome reception, we had a total of 23 registered participants. By the end of the reception, this number increased to 50 participants. By the second day of the conference, we had a total of 81 registered participants. We noticed another surge in registration during the coffee-break and poster reception on the first day of the conference. Participants at registration often commented on how they saw the ties light up and so decided to participate.

Registration stopped after we ran out of functional ties. Of the 95 ties we manufactured successfully, 73 survived the trip to Baltimore. Therefore, only 73 of the 81 registered participants received ties. We continued to get requests to participate throughout the conference even after shutting down registration.

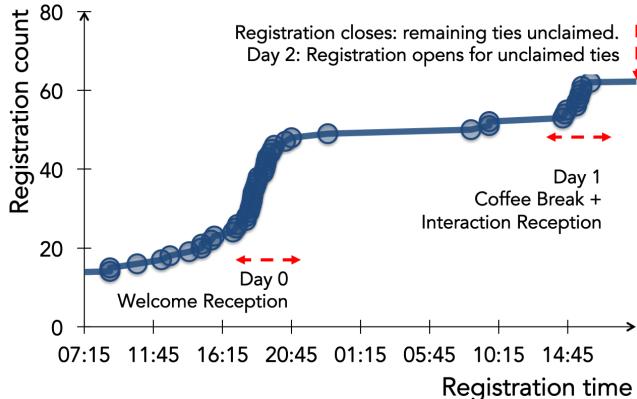


Figure 2. CommonTies Participation. Participation did not rise at all breaks, the two workshop days before the conference had no increase in participation despite our booth and pamphlets distributed.

The conference venue floor plans are shown in Figure 3. Our system was setup in the West Foyer (top, blue shaded area) where the Welcome Reception (120 minutes the evening before the 3-day conference), and six Coffee Breaks (30 minutes each) took place over a period of three days. We also setup in the Grand Ballroom (center, orange shaded area) during the Poster and Demo (45 minutes) and Interaction Reception (120 minutes). According to our conference context definition, CommonTies suggested matches only during the receptions, coffee breaks, and poster/demo sessions to avoid interfering with any talks.

Information Disclosure

One immediately interesting observation is how willing users were to provide access to personal and professional information to enable better matchmaking. Each registered user

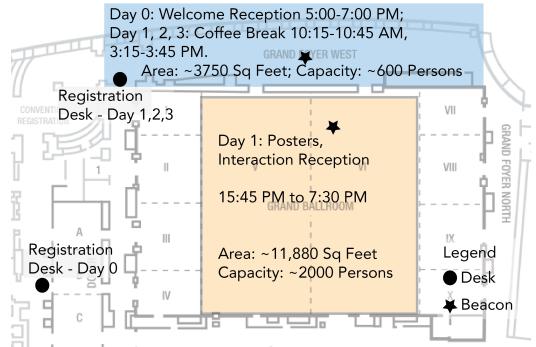


Figure 3. The floor plans and capacities of two CommonTies interaction spaces at CSCW 2014. Any tie within the shaded areas was detected by the beacon.

was required to only provide their full name and email. This allowed us to mine public information such as a user’s co-authors.⁴ In addition to public information users can optionally provide access to their LinkedIn profile and first-degree professional network, their Facebook profile, and first-degree friends network as well as access to papers liked on CSCW’s conference scheduling application, Confer. Table 1 summarizes the participant’s disclosure patterns.

Sources of personal information	Number of users (Perc.)
Confer	57 (70.3%)
LinkedIn	52 (64.2%)
Facebook	49 (60.5%)
All three sources	27 (33.3%)
Only two of the three sources	27 (33.3%)
Zero sources	4 (4.9%)

Table 1. Information sources that the 81 users allowed access to.

A surprising 60% provided access to Facebook, which holds more private, less professional, social network information. The main reasons for not providing access to the additional information sources were forgotten passwords or users not having LinkedIn, Facebook or Confer accounts. Many users preferred alternate professional network sites like academia.edu to LinkedIn. This willingness of users to disclose personal information to a third party to enhance their social interactions does not imply that users are willing to give the same information to strangers.

Did CommonTies enable interactions?

CommonTies made 372 suggestions (186 matched pairs) over a total period of seven hours. We asked users to recall the number of times they noticed their tie glow and the number of matches with whom they interacted. Table 2 provides interaction statistics across a subset of only forty users who thoroughly reported their interactions. Thus, we can only provide interaction statistics on 315 of the 372 suggestions made due to respondents providing incomplete forms or inaccurate data.

We also observed and photographed several interactions ourselves. Figure 4 illustrates one successful match we captured in a photograph.

⁴Since co-authors are not strangers, we do not match them.

Interaction Data	Total*	Mean per user
Matches Suggested	315	7.88
<i>Self-reported interactions data</i>		
Glows noticed	155	3.88
Interactions	58	1.45
Useful interactions	43	1.08
<i>Mean Proportions</i>		
Glows noticed over matches suggested	0.52	
Interactions over matches suggested	0.15	
Interactions over glows noticed	0.29	
Useful interactions over all interactions	0.74	

Table 2. *Only 40 respondents provided figures for all interaction questions — we show results only for this subset. CommonTies logged a total of 372 matches (186 pairs).



Figure 4. A successful match!

Noticing the glow

Users only noticed 52% of their tie-glowes. We partially attribute this low noticeability to the following:

- Glows are too subtle: Some users commented: “Comfortable, easy to wear. However, also easy to disregard under a long sleeved shirt,” “It’s not very intrusive, so that is nice. However, it’d be probably more effective if it’d vibrate. I might have missed the lighting up once or twice.”
- User fatigue: “While it was fun using it initially, I felt that it lost some of its fascination after a little while. Thus, I stopped using it and engaged in conversation by normal means”, “I mostly forgot I had it.”
- Ties are always on: one user hid her tie in her backpack because she was “busy ... at the poster session” — the tie continued to work in such scenarios. Another commented “I am probably a bad data point because after day 1, I did not want to bother with it and quit wearing it. I did keep it with me, however, in my bag. If it could have notified me from my bag, maybe that would have helped.”

Missed interactions

The mean number of self-reported interactions per user was 1.45. Only 15% of suggested matches concluded in self-reported successful interactions. Beyond simply not noticing the glows, which we accounted for above, we extracted the following reasons from user comments to explain the missed interactions:

- Users engaged in conversations did not disrupt them to look for matches.
- The crowd and the large interaction space made locating a match challenging. We asked users to rate how easy it was to locate a match on 5-point Likert scale from one indicating hard to five indicating easy (Table 3). The mean rating was 1.97.
- User fatigue: “I stopped looking for them after the 5th match because it got a bit too much ... BUT when I looked for them, I always found them at some point.”
- Users who could not locate initial matches were demotivated from finding later matches. Similarly, users who did not notice initial glows were demotivated. For example, one user commented: “It did not really glow at all. So I stopped using it.” This user’s tie glowed five times.
- Users who hid their ties made it impossible for their matches to locate them.

A successful interaction requires that users: a) notice the glow, b) willingness to meet a stranger, and c) find their match. It is our opinion that 15% of glows resulting in interactions was reasonably high given the sequence of barriers leading up to a successful interaction. When people notice their glows, 29% of the time users decided to take action and were able to find their match. Unfortunately, we do not have numbers for the proportion of users who intended to find their match to perfectly triangulate this process, but based on the comments we believe that difficulties finding matches was the limiting factor rather than willingness to be nudged.

Interactions and diminishing returns

From our data we observe that there is currently a “sweet spot” where the number of suggested matches would maximize the number of interactions without inundating users with too many glows.

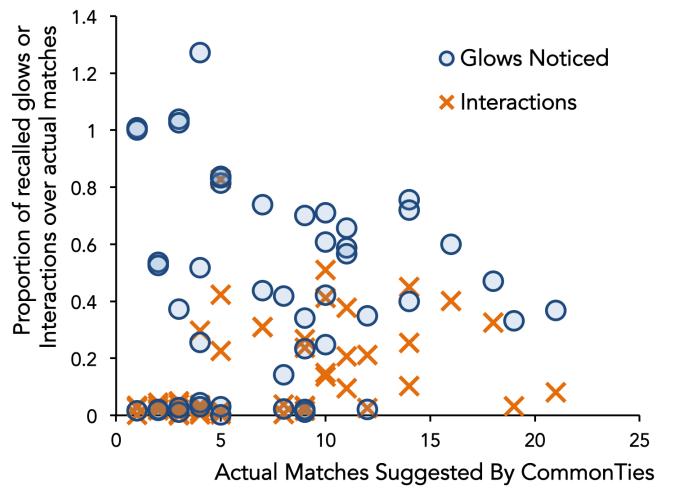


Figure 5. Proportion of glows noticed by, and interactions for each CommonTies participant.

Figure 5 plots the proportion of glows reported by a user against the number of times the user’s tie actually glowed (circles). Initially, as the number of suggested matches is low, a large but highly variable proportion of glows are noticed as we would expect. As the number of suggested matches

increases this proportion tapers off. In the same figure, we also plot the proportion of successful interactions reported by a user against the number of times the user's tie glowed (crosses). Here, when the number of suggested matches is low, the number of successful interactions is also low, but as the number of suggested matches increases, the proportion of interactions increases until it tapers off (and is limited by the dependence upon the glows first being noticed).

We can determine a sweet spot for our deployment of around 10 to 15 matches suggested where users both notice glows and follow through with interactions. After reaching this point, suggesting additional matches results in diminishing returns on the number of interactions.

Survey Responses

Table 3 provides a summary of user responses to our survey questions. For each question in Table 3, users were given the opportunity to elaborate on their rating in free-form text. For the remainder of this section, we use this data to answer several questions regarding the response to CommonTies.

Likert-Scale Survey Questions	Mean	Dist.
I could locate my match in the time period that the tie glowed.	1.97	■■■■
CommonTies suggested novel & useful matches.	3.14	■■■■
Getting more information about the matches (name, profile, etc.) would have been helpful.	3.64	■■■■■
I liked the form factor (look, feel & aesthetics) of CommonTies.	2.78	■■■■
I enjoyed using CommonTies.	3.24	■■■■
I would use CommonTies again.	3.76	■■■■■

Table 3. 62 Respondents evaluated each of the above statements on a 5-point Likert scale from 1-Strongly Disagree to 5-Strongly Agree. Of these respondents, CommonTies provided match suggestions to 52 respondents and 23 respondents had at least one interaction as a result.

Were the interactions novel and useful?

Despite the challenges associated with noticing glows and locating matches, users reported that 43 of the 58 (74%) interactions they did complete were novel and useful (Table 2).

On a 5-point Likert scale, we asked all participants to rate the novelty and usefulness of their matches (Table 3). Of the 23 participants who interacted using CommonTies, the mean rating was 3.14. Qualitatively, our users either reviewed their matches positively — “[The] second match was extremely useful - great conversation, access to different literature/perspectives on same topic; especially useful because this person wasn't connected to my existing network,” “All of [the matches were] novel, most of them useful ... two of them really useful” — or somewhat neutrally — “The one person I found was pretty surprising - the connection seemed tenuous.”

From the user comments, we found that while all users found their connections mostly novel, they disagreed on their utility. As one user puts it “The connections made were all novel apart from one. Whether they were useful or not only time will tell.”

How did users feel about the lack of information?

On a 5-point Likert scale, we asked users to rate how helpful they would find getting more information about suggested

matches from one indicating they strongly disagree to five indicating they strongly agree. The mean rating was 3.64.

To tease apart the reasons behind requesting more information, we examined the users' comments on this question and found that of the 37 people who agreed or strongly agreed to getting more information:

- Seven users were actually looking for *talking points*: “what should we talk about?”, “[the] reason for match is all I wanted. No name or additional (possibly privacy-invading) info needed”, “[information] for introductions - definitely!”
- Six users were looking for information that could help them *locate* their matches: “[a] picture would help identify the match,” “if we missed the match, it would be nice to know how to contact them later,” “[I] couldn't find them when my thing lit up. So may be who to look for would help.”
- Six users’ were looking for *profiles* typical of online match-making sites. One user wanted a list of recent publications for each match. Two users wanted a mobile app version that showed more information. One user wanted a web-page with a list of all matches.

The remaining participants provided no explanation for their desire for more information.

While many users wanted more information, only six (10%) of them were explicitly looking for profile information. Many users expressed appreciation for the limited information that CommonTies provides: “[I] kind of liked the serendipity - getting to know you in actual conversation [is] kind of the point!” “The mystery is the fun!” “I prefer not to know, it would reduce the fun, serendipity factor.” “I think people still prefer to introduce themselves normally.”

Even amongst the participants who wanted more information, some recognized that “it might ‘short circuit’ the discussion/social process of talking through and finding the overlap ‘manually’ with a match.” At least two users disagreed to providing more personal information to our system due to privacy concerns.

Did users like the tie’s look and feel?

On a 5-point Likert scale, we asked users to rate the look, feel and aesthetics of the tie from one indicating they strongly disliked the tie to five indicating they strongly liked it. The mean rating was 2.78.

Users were also asked to elaborate on their rating. Among the 28 users that negatively rated the tie, 23 users (82%) explained that discomfort due to a tight elastic wristband or coarse 3D plastic was the reason behind their negative rating. Even though we had varying wristband sizes, we allowed users to pick their own ties, which led to a poor allocation: “[I] picked a wristband that was a little too tight”.

With respect to aesthetics, comments ranged from, “pretty snazzy”, “[it] looked cool. When it lit up”, “Fashion statement, anyone?” to “Kind of ugly and utilitarian at this stage.”

Did people enjoy using CommonTies?

We asked users to rate how much they enjoyed using CommonTies on 5-point Likert scale. The mean rating was 3.24.

We also asked users to rate how interested they would be in using CommonTies again. The mean rating was 3.76.

Finally, we wish to provide you with the following collection of comments, which capture some of the responses and intellectual discussions that CommonTies brought to CSCW:

- “I loved the excuse to talk to random people. I’m the kind of person that does not struggle to find conversation with strangers, but I often lack the excuse to do so.”
- “I had positive experiences with meeting people through this system, but it did disrupt my usual way of navigating conference social events.”
- “It didn’t glow. I spent a lot of time waiting in anticipation.”
- “It was fun to glow ... meet people ... it got me out of at least one conversation I wanted to escape from.”⁵
- “I’m not sure that the matching was not 100% random and I think it worked just fine.”
- In response to whether the user would like to adjust the matching criteria: “Nope. Then I’d probably subconsciously exclude certain people.”
- “We all found it really novel and started discussing about it and guessing if it would work. Like hacking the experiment and building upon it.”

DISCUSSION

We found many interesting reactions to CommonTies at CSCW. While some of our findings are broadly generalizable, others are likely to be specific to our deployment. Here, we discuss the themes and factors we observed at CSCW to contextualize our results.

We believe that the fundamental driver of the level of engagement we observed was the comfortable environment of the conference. From our own first-time experience at the conference, the friendly and relaxed attitude of conference attendees appeared to invite casual interactions with strangers. Also, the intellectual and social curiosity of the attendees also likely contributed to the uptake of our system and people’s willingness to meet strangers. Moreover, when a nudge was observed, our participants earnestly searched for and interacted with their suggested matches, which may not be the case at other conferences.

Several limiting factors were directly attributable to our design choice toward unobtrusiveness: the inability to notice glows, difficulty in finding matches, and matching already engaged users. The missed interactions caused by these barriers eventually resulted in user fatigue. Based on participant feedback, we believe that these design choices should be shifted toward more noticeable notifications, easier matchmaking, and a do not disturb mode. These changes would better fit user expectations and needs, and could be implemented without violating our design principles.

Specific to CSCW, the 30-minute coffee breaks were too hurried to get into a relaxed and playful mood. We observed the most connections during the initial reception and at the demo session. Furthermore, a substantial reason for fatigue was the

duration of the deployment lasting for three days. By the end of the conference, the novelty of CommonTies wore off.

Profiles and Information Disclosure

Interestingly, we found that most people were satisfied with the informationally-minimalistic interface of CommonTies. Furthermore, of the people who wanted more information, only a few wanted explicit *profile* information. This suggests that up-front or visible profile information may be unnecessary for networking at conference-like contexts and raises a broader question about whether profiles are necessary for meeting strangers in other contexts.

We suspect that three main components to the experiment led to our result. First, conference attendees are specifically interested in meeting new people. CSCW being such a close-knit community (unlike a large convention or a general public space) meant people felt more comfortable, and were willing to be more open to new people and experiences. Second, the conference was for a short duration. We found evidence that engagement with the system deteriorated as the experience grew longer. Third, CommonTies was small scale and designed for immediate, synchronous, face-to-face interactions. Large scale computer-mediated communication (CMC) systems generally enable anonymous, asynchronous communication at scale. The resultant abundance of choice online motivates the introduction of mechanisms for helping users sift through and evaluate options (e.g. user profiles, sophisticated matchmaking, searching, filtering, etc.).

The Matchmaking Algorithm

The matchmaking algorithm we employed was simple. Yet, despite this simplicity, people who interacted were happy with the novelty and usefulness of their matches. While this is not an argument against more sophisticated matchmaking algorithms, in a small conference context where attendees self-select based on similar interests or attitudes, it appears sufficient for a matchmaking algorithm to capture the notion of strangers.

We expect that completely random matches would be acceptable at a welcome reception of strangers, but would not work well in the CSCW context because many attendees already know each other. Re-matching known acquaintances would increase user fatigue and decrease engagement with our system. If we consider only randomly matching strangers, it is possible that more users would guess that the algorithm is random, leading to more serendipitous explanations. However, disclosing the specific matchmaking algorithm would likely reduce the sense of mystery.

Other algorithmic changes should have relatively predictable outcomes. For example, removing the Confer data from matching would reduce the amount of common interests, but perhaps enough talking points would emerge spontaneously given the common interests among CSCW participants. Removing the segments and career levels would decrease the cross connections between the respective social groups (i.e. industry folks would meet fewer academics and students would meet fewer faculty).

⁵Glad to help.

Mystery and Play

Given the lack of profile and matching information, as well as match location, the effort our participants went through to find their match was exceptionally high. We believe that by not revealing the matchmaking algorithm, we successfully facilitated a sense of mystery and allowed participants to assign their own explanations and interpretations to the experience.

The information-scarce design of CommonTies was not appreciated by everyone, but of the people who did engage with the system there was an overwhelmingly positive response to the mysterious and eventual game-like elements of CommonTies.

The difficulty of locating matches led to unanticipated and playful user behaviors. Many participants raised their hands and searched the interaction space for their match creating what appeared to be a hide-and-seek gamification of CommonTies (see Figure 6): “It was often difficult to find the ‘common tie’ in a large room but this led to funny ‘game-like’ or playful exchanges where people would roam around holding up their bands to find their ‘tie’”.

In this game, many participants took the assistive role of finding matched pairs and bringing them together: “A volunteer tracked down my match when I couldn’t find him.” “At no time I could find my match. One time some other person showed me.” “It was fun to see wrist bands lighting up around and seeing people match up and chat.”

Re-orienting Interactions

Our original inspirations for this work, Collins and Miller [8] and Walther [31], discuss the tensions between the implicit goal of offline face-to-face interaction and the convenience of the online medium. Walther describes how presenting abundant matches can cause “people to make lazy, ill-advised decisions when selecting [partners to contact]” and how computer-mediated communication via email or messaging prior to face-to-face meetings “can produce unpleasant expectancy violations” because people have presented an idealized version of themselves online.

Some systems manage to cleverly balance these tradeoffs by using location information (e.g. GPS) to help match people to each other based on real-time real-world location. Unlike these systems, CommonTies was designed to avoid these undesirable outcomes by obviating the need to sift through profiles or re-orient back to the offline. Although we did not specifically study whether we avoided ill-advised decision making or unpleasant expectancy violations, we did show that in small conference settings the mechanisms that were attributed to producing these consequences (profiles and online interaction) were not always necessary for catalyzing interactions. Moreover, we demonstrated how the removal of

these mechanisms could be leveraged as a design resource for mystery or enchantment as argued by Gaver [11] and Sengers [29].

Generalizability and Limitations

We are very cognizant of the experimental challenges demonstrating repeatability and generalizability of some of our results. We have demonstrated that for CSCW-like contexts a gentle nudge is sufficient to turn a stranger into an acquaintance, but many participants were likely biased toward engaging with our system out of research curiosity. Also, re-deploying CommonTies at CSCW is problematic as people have already used the system. Other events would inevitably have their own nuances.

CommonTies is designed for events where a sense of play is within acceptable social norms. In a museum, people may want to enjoy the exhibits and be left alone. We would also expect CommonTies to make sense in safe curated venues compared to large unfiltered spaces (e.g. on a public street with complete strangers). We believe that for larger and less relaxed contexts like job fairs, efficiency focused systems would be more appropriate than mysterious designs.

FUTURE WORK

CommonTies V2.0

Based on our results and user feedback, CommonTies could benefit from a few simple improvements that remain in line with our design principles.

First, many interaction opportunities were missed because users missed the subtle visual cue of the tie glowing. We plan on adding an initial, soft, vibration that may be muted by the user or during ongoing interactions (based on proximity to other ties). Users can still choose to ignore the nudge, but will be less likely to miss the cue.

Second, to enable users to locate their matches, while still maintaining the playfulness of searching for a match, we plan to have the beacons serve as gathering points glowing with the same color as the tie and changing the steady tie glow to a slow pulse that increases in frequency as users get closer.

Third, we plan to change the matchmaking algorithm to avoid matching muted ties and tune the number of suggested matches to the level of pursued interaction. This improvement would also help reduce unfindable matches (e.g. in the case where the tie is nearby but hidden in a bag), and also allow CommonTies to be more sensitive to user fatigue and temperament.

Research directions

In addition to system improvements, there are numerous interesting research questions prompted by our analysis of the large CSCW field experiment. We wish to answer some of these questions. First, do the ideas from CommonTies generalize past the context of tight-knit conferences into other social contexts and interaction spaces: for example, could subtle nudges enable social interactions in other contexts? Second, we plan to study the effect of context on information disclosure: how much information are users willing to provide and



Figure 6. A participant raises his hand while he searches for his match.

to share to meet strangers in different settings? Third, how does CommonTies compare against other networking tools?

CONCLUSION

In this paper, we described CommonTies, a simple technological nudge in the form of a privacy preserving wearable accessory, that encourages immediate, face-to-face, social interactions among strangers at conference-like settings. We designed, implemented, and eventually evaluated CommonTies at CSCW 2014 during a three day in-situ study. We demonstrated that without revealing profiles or any private information about matches, users were willing to interact with strangers. We found that our informationally minimalistic design coupled with a simple matchmaking algorithm was sufficient to suggest novel and potentially useful meetings 74% of the time. Overall, there was a positive response to the mysterious design and emergent game-like elements. CommonTies represents an interesting point in the design space of conference networking tools.

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