Designing for Inclusion: Supporting Gender Diversity in Independent Innovation Teams

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ABSTRACT
We study how independent innovation teams develop an environment of inclusion to support gender diversity. Through a mixed-methods study involving surveys and interviews with people involved in independent innovation, we sought to better understand the mechanisms by which their teams fostered a sense of inclusion to support gender diversity via interpersonal practices and communication and collaboration technology usage. By understanding how inclusion supports gender diversity, we discuss design implications to help more diverse independent innovation teams form and function.

Author Keywords
Diversity; Gender diversity; Teamwork; Socio-technical tools; Collaboration; Community

ACM Classification Keywords
H.5.3. [Information Interfaces and Presentation (e.g. HCI)]: Computer-supported cooperative work

INTRODUCTION

Innovation activity drives the growth of our economy by introducing new products and services that change the way we live and interact. With advancements in communication and collaboration tools, it is easier than ever to form and work together in *independent innovation teams*—teams assembled outside the context of an enterprise that aim to create new artifacts, products, or services. For example, an independent innovation team could be a startup developing a new mobile application, a group of hobbyists designing a new Arduino device, or a collaboration between artists and technologists to create an interactive community art installation.

However, self-formed teams tend to be less diverse than those created under managerial leadership [8]. Having less diverse teams limits innovation because diversity positively influences team performance in problem-solving capabilities and creativity [4,56,63,80]. Unfortunately, simply assembling diverse teams does not necessarily lead to positive outcomes. Successful diverse teams need inclusive work environments that limit friction, yet bring out the positive benefits of having different people work together [19,60]. Feeling included is associated with greater team loyalty and work ethic [1], which are important factors in helping diverse teams thrive [82]. We define *inclusion* in the workplace as being given equal opportunities, the ability to influence decision-making processes, and opportunities to establish personal connections with others [2,60]. We ask, *how do independent innovation teams foster inclusive work environments,* and, *what is the role of the surrounding socio-technical environment in supporting inclusion during diverse team formation and ongoing work?*

Because independent innovation teams have no overarching corporate structure, it is imperative to understand how these teams develop inclusion and how aspects of the socio-technical environment, including surrounding creative communities and technologies used, influence the psychological experience of working together. While many sociocultural factors determine *what* information is shared, communication and collaboration technologies affect *how* people communicate and whether or not individuals appear as capable or trustworthy [22,54]. Informed by our empirical findings, we contribute design implications to better foster inclusive work practices in independent innovation teams.

Given the scope of this study, we limit our focus to gender diversity as gender minorities face unique barriers to opportunities in many innovation settings [85]. For instance, as the number of new male entrepreneurs continues to increase, the number of new female entrepreneurs is decreasing [29]. Designing gender inclusive technologies is a key direction in the future of HCI work [16]. However, few have studied opportunities for better gender diversity and inclusivity from the lens of communication and collaboration technologies for teams. Motivated to reduce the gaps in innovation activity between genders and to build on existing HCI work on gender inclusive technologies, we use an empirical study to understand how socio-technical systems can better support gender diverse team formation and ongoing work.

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We adopted a mixed-methods approach by first surveying 132 people involved in independent innovation teams to understand the relationship between gender diversity, technology usage, and perceptions of inclusion. To gain a richer understanding of what factors affect feelings of inclusion in the team, we then performed follow-up interviews with 20 people who have been or are involved in independent innovation teams of varying gender diversity. We conclude with a discussion and design implications for how communication and collaboration technologies could support diversity by fostering more inclusive work environments.

RELATED WORK

In order to understand how to support gender diverse independent innovation teams, we must also study the surrounding socio-technical environment—technologies being used and communities from which they form.

Supporting Gender Diversity Through HCI

The success of gender-diverse teams is influenced by how members feel in work environments [60,67]. This may explain the conflicting findings on the effects of diversity because simply creating diverse teams does not inherently produce positive outcomes. Some find evidence that gender diversity supports higher levels of team innovation [63], problem solving ability [39][26], and healthier work climates [27], while others find that it interferes with team innovation [40,77] and causes greater interpersonal friction, such as increased misunderstandings and conflicts over power and responsibilities [82].

Creating an inclusive work environment has been shown to mediate the relationship between diversity and conflict in teams [60]. A climate of inclusion is fostered by providing equal opportunities in the workplace, the ability to inform decisions, and opportunities to get to know each other and be accepted for oneself [2,60]. Many of these tenants are parallel to the central commitments of feminism—agency, fulfillment, identity, equity, empowerment, diversity, and social justice [7]. Bardzell argues that by designing interactive systems with these commitments in mind, we can foster more socially aware and higher quality interactions. In this study, we seek to understand how social practices and technologies are adopted and used to support values of inclusion in the context of independent innovation teams.

Theories of socio-technical systems have described how the history of male-dominated technology development has limited the design of communication and collaboration tools [7]. While many have focused on creating tools to increase team productivity [31,35,62], few have focused on how these tools support gender inclusive team work environments [38]. Previous work on gender inclusive technologies have primarily focused on how men and women use software differently. This work finds that women tend to have lower self-efficacy when using software, which means they are less likely to explore and use new features that could improve their work practice [9–11,15,17].

Others described how technologies influence inclusion in distributed teams [38]. Some find more personal communication tool usage, like phone or video calling, allows people to more easily find common ground [79] and express themselves in delicate social situations. Furthermore, collaboration tools that foster greater transparency, such as seeing each others' profiles and project work, help form impressions about someone's personality and skills [22,54].

We build on this research to understand how communication and collaboration tools support inclusive practices in the formation and ongoing work of independent innovation teams. However, we acknowledge that communication and collaboration technologies are used in a greater societal context, and that simply changing a team's technology usage will not necessarily change interpersonal behavior. Comparatively, technology is not just the messenger, but a way to support relationship building based on its designed affordances [7], providing a possible avenue for affecting how diverse teams form and function.

Communities and Cultures of Innovation

A team's environment is also often a reflection of the communities in which it belongs. Because independent innovation teams tend to be less diverse than those created in the context of managerial leadership [8], we explore whether non-enterprise communities take the place of companies in providing norms that shape team culture. We see evidence that creative communities, such as hackerspaces [6,32,51], co-working spaces, art groups, craft groups [75], and DIY communities [47,65], provide resources, social expectations, and interpersonal support needed for team formation.

Creating an environment where people can safely test ideas and connect with others is crucial for creating a healthy work environment, especially for marginalized individuals who may feel judged on their differences. Research on persistence among underrepresented populations describes the importance of interacting with role models and demographically similar peers to support feeling included [52,83]. In addition, limited resources and not feeling like one belongs are major factors in why minorities often leave new environments [37,82]. Creative communities not only connect people with similar interests [81], but also provide a place where people have the resources and social support to produce new innovations in a safe environment [7,32].

In order to support gender diverse teams that form from these communities, we must understand how people interact in these community environments. Previous HCI researchers have studied the pros and cons of community communication channels [84] and have built web platforms to support community decision making [25,50]. For instance Zhang et al. highlight how mailing lists, one type of community communication tool, support "serendipitous discoveries" of content, but limit further discussion [84]. We contribute to this related work by understanding how these technologies support or hinder gender diverse independent innovation team forming from community environments.

PART 1: SURVEY

We first performed a survey study of 132 people involved in independent innovation teams to understand how team technology usage and gender diversity interact to influence perceptions of inclusion and innovation.

Methods

Procedure

Participants were required to be involved in teams of three or more people formed within the past five years with a goal to create a new artifact, product, or service. We recruited participants through 15 email lists for maker groups (e.g. Dorkbot), co-working spaces (e.g. Impact Hub), and art and tech communities (e.g. Burning Man). We also recruited from female-based project groups (e.g. Geek Girl Carrots) to sample for a representative number of women. Furthermore, we recruited through Craigslist and advertisements placed in city newspapers to reduce bias towards those involved in existing communities.

During recruitment, participants were told that the study was about understanding how independent innovation teams formed and worked, and how new technologies could be designed to support this process. Participants were not made aware that the study was primarily on team diversity in order to limit self-selection towards individuals who were more open to diversity practices. The majority of the survey asked questions about team formation, community involvement, and basic demographics. Each participant completed the 20-minute survey and were gifted a $10 Amazon gift card as well as given the opportunity to sign up for a one hour follow-up interview for an extra $50. Survey data was analyzed while interviews were being performed, which allowed semi-structured interview questions to be updated over the course of the study.

Survey

The survey asked questions about personal demographics, technology use, feelings of inclusion, and perception of team innovation. We also asked similar questions about being involved in a greater community as previous work describes the importance of community culture on team environment [81]. The following variables were collected:

Individual Variables

Demographics. Participant gender, race, and age.

Team and Community Perception Variables

Demographics. Participants reported the team type(s) (technological, art, maker, entrepreneurial) and number of people involved.

Gender Diversity. Gender diversity at the team level was calculated using the Blau diversity index [12], which gives the probability of picking two people of the same type (with replacement). Team level gender were self-reported by participants. Participants estimated community level demographics by giving the percentage of each gender.

Technology Use. Technology use was measured by asking on a scale of 1 to 7 how important 18 types of communication and collaboration tools [30] were for interacting with one's teammates and community members (1=Not at all, 7=Very much so).

Inclusion. Personal feelings of inclusion were measured using five items adapted from a standardized measure of inclusion and exclusion in workplace environments [58]. For team perceptions, items included, *'I feel part of informal discussions in this collaboration'* and *'I am able to influence collaboration decisions.'* For community perceptions, items included, *'I feel part of informal discussion in this community,' 'I am able to influence community decisions,'* and *'I feel isolated in this community'* (1=Not at all, 7=Very much so).

Innovation. Perceptions of innovation were measured using five items adapted from Anderson and West's standardized measure of work group innovation [3]. For team perceptions, items included, *'This collaboration is always moving toward the development of new answers,'* and *'This collaboration is open and responsive to change.'* For community perceptions, items included, *'This community is always moving toward the development of new answers,' 'This community is open and responsive to change,'* and *'Assistance in developing new ideas is readily available in this community'* (1=Not at all, 7=Very much so).

We emphasize that these are individual perceptions of the team and community. We collected individual perceptions because it is their perceptions that influence how they feel and act within the team, which determines whether they stay in the team and future decisions to participate in independent innovation teams. Furthermore, we feel that perceptions of team diversity are fairly accurate as most teams had less than ten people, making it easy for participants to recall team members' gender.

Participants

We initially received 197 responses within a three-month period. We excluded 3 under the age of 18, 50 from outside the United States, and 12 for filling out less than half of the survey. We focused on people in the United States in order to minimize confounding factors related to differences in work practices between countries. Of the remaining 132 participants, 40.2% were female. One participant identified their gender as non-binary. Ages ranged from 20 to 61. 76.5% identified as Caucasian, 1.5% Black or African American, 7.6% Asian, 3.8% Hispanic or Latino, and 4.5% Native American. Of these participants, 5.3% were of mixed race.

Survey Results

Teams were on average 41% female. For male respondents, 65% of their teams were reported to be a majority male (33% all male). For female respondents, 50% were a majority female (7.5% all female). The measure of team gender

	Collaboration		Community	
Socio-technical Tools	***Mean***	***SD***	***Mean***	***SD***
Email (one-to-one)	6.0	1.34	5.8	1.64
Online file sharing	5.0	1.99	4.6	2.11
Real-time doc editing	5.0	1.89	4.9	1.94
Phone calling	5.0	1.87	4.9	1.95
Email lists	4.9	2.19	5.8	1.48
Mobile text messaging	4.7	1.95	4.9	1.91
Calendar sharing systems	4.6	1.95	4.8	1.99
Social networking sites	4.2	2.11	5.3	1.80
Video calling	4.2	2.29	4.6	2.07
Online chat	4.1	2.23	4.5	2.16
Website or blog	4.0	2.27	4.7	1.99
Code sharing systems	3.8	2.44	3.8	2.27
Online discussion boards	3.7	2.33	4.9	2.06
Project management	3.7	2.36	4.2	2.20
Video sharing sites	3.6	2.14	4.2	2.10
Photo sharing sites	3.5	2.32	4.1	2.13
Online member directory	3.3	2.36	4.3	2.27
Other mobile messaging	3.1	2.40	3.8	2.34

Table 1. Mean importance of socio-technical tools for communicating and sharing, in either collaboration or community contexts, where 1 = not at all and 7 = extremely so.

diversity ranged from 0 to .5 with a mean of .35 (*SD* = .19). This meant that on average, if one were to choose two random people from a team, there would be a 35% chance of choosing two people of the same gender. The majority of the teams were ten people or less, with 38.6% 3-4 person teams, 23.5% 5-10, and 25.8% 11 or more. Teamwork was performed collocated (*M* = 5.17, *SD* = 1.63) and distributed (*M* = 5.2, *SD* = 1.69) (1=Very rarely, and 7=Very much so).

Communities were on average 44% female with gender diversity of .40 (*SD* = .18). Participants for the most part reported that their independent innovation team belonged to a larger community context (*M* = 5.9, *SD* = 1.47), and that they themselves were involved in this community (*M* = 5.7, *SD* = 1.42) (1=Not at all and 7=Very much so). These community contexts included co-working spaces, makerspaces, startup groups, and arts communities.

Technology Usage

Participants were asked how important various communication and collaboration technologies were for interacting with team and community members. Between *team* members, email was rated as most important, followed by online file sharing, real-time document editing, and phone calling. Between *community* members, email and mailing lists were reported as most important. See Table 1.

In order to identify the key factors in technology usage, we performed a factor analysis (with varimax rotation) on the ratings for these tools. At both the team and community levels, three factors emerged with factor loadings over 0.6 and an eigenvalue over 1: **1) group communication** referred to tools that typically supported one to many communication, such as online discussion boards, social networking sites, mailing lists, and online member directories; **2) personal communication** referred to tools that typically supported one-to-one or richer communication, such as personal emails, phone calling, and video calling, and **3) project collaboration** referred to tools that typically supported work sharing and collaboration, such as online file sharing tools, code sharing systems, real-time document editing tools, and project management systems.

Team:	Inclusion	Innovation
Participant Variables		
Female	.15	**.33**
Team Perception Variables		
Gender Diversity	-.03	.11
Project Collaboration Tools	-.10	**.26**
Group Communication Tools	**-.55**	.05
Personal Communication Tools	.17	**.32**
Community Perception Variables		
Extent team is in community	.12	**.47**
Gender Diversity	.11	**.21**
Inclusion	**.39**	**.28**

Table 2. Pearson's correlations between diversity, importance of socio-technical tools, collaboration inclusion, and innovation, at both the collaboration and the community level. Bolded items are significant at the p< .05 level.

Environment for Inclusion and Innovation

We first examined the relationship between diversity, inclusion, and innovation through Pearson correlations. As can be seen from Table 2, women tended to rate their collaborations as more innovative than did men. The team's gender diversity did not overall correlate with perceptions of team inclusion or innovation. However, participants in teams that more often used group communication tools were less likely to rate their team as inclusive.

To understand the role of community, we performed Pearson correlations and found that feelings of inclusion in the community were positively correlated with team inclusion. We also found that community membership, community gender diversity, and feelings of inclusion were positively correlated with perceptions of team innovation. See Table 2. Perception of community level of gender diversity was also significally correlated with team gender diversity ($r(130) = .62$, $p < .01$). We refrain from making bold claims as these variables are individual perceptions of the team and community. However, we find it useful to see how individual perceptions about one's team are highly related to one's perceptions of their community.

To test the relationship between gender status, technology usage, and inclusion, we performed a regression analyses for

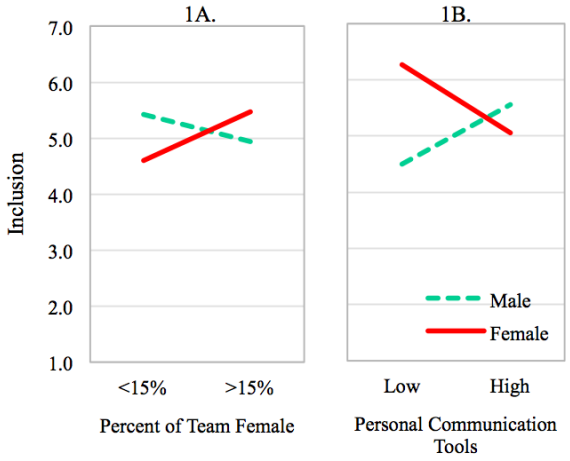

Figure 1: Women feel more included the more women there are in the team while men feel less included (1A). Women feel less included the more the team uses personal communication tools, while men feel more included (1B).

male-dominated technology-based teams to test for main and interaction effects. Teams were classified as male-dominated if they were 85% or more male based on the minority effect—negative effects of minority membership become particularly pronounced in groups that have only a small percentage (one or two people in small teams) of the minority group [41]. We found a marginally significant interaction effect where in male-dominated, tech-focused teams, females felt less included, and men felt more included ($F(1,54) = 3.15$, $p < .08$, 2-tailed, $\Delta r^2 = .05$). See Figure 1A. We also found that women in male-dominant, tech-focused teams felt *less* included in teams that used personal communication tools more, whereas men in male-dominant, tech-focused teams felt more included ($F(1, 42) = 6.16$, $p < .05$, 2-tailed, $\Delta r^2 = .10$) See Figure 1B.

PART 2: INTERVIEWS

We sought further information with interview data to understand *how* independent innovation teams foster inclusive work environments, and the role of the surrounding socio-technical environment (e.g. technology, community) in this process. We performed follow-up interviews with people involved in both high and low gender diverse independent innovation teams.

Methods

Participants

We follow with a nested study design [68] by recruiting 20 interview participants from the initial survey population. This allowed us to reinforce and further explain the source of the survey results. In order to better understand perspectives in high and low gender diverse teams, we performed a theoretical sampling [34] by recruiting participants who worked on teams representing a range of gender diversity. We interviewed 20 participants (13 females), including 2 African-American, 2 Hispanic/Latino, 3 Asian, 2 of Native American/Caucasian mixed race, and 11 Caucasian participants.

Procedure

Interview participants were selected by contacting every survey participant who expressed interest in being interviewed, following up more with female participants in order to get a gender balanced interview sample. However, only a fraction of these interested participants were actually able to participate in the interview given the time commitment of meeting at a quiet location with access to a white board. Interviews were on average 1-hour, took place in person both during the weekday and weekend, and were both audio and video recorded. Participants were also gifted $50 or a comparable amount in company products for their participation. We followed a semi-structured interview protocol where we asked questions about collaboration environment, diversity of people involved, role of a greater creative community, and participant's experience as a gender minority in their team if relevant.

To better understand the role of technology, we asked what communication and collaboration technologies were adopted or dropped, in what situations were certain technologies used, who preferred which technologies, and how they felt when communicating with team members through these different mediums. We initially found that participants were uncomfortable answering questions like, "How do you think technologies supported gender diversity in your team?" Rather, participants responded much more openly to questions of whether or not they felt included in their team and what roles technology and social practices played in supporting positive or negative interpersonal experiences. Stepping back and asking these broader questions about inclusion made it easier for participants to share stories in the context of technology use. Participants were able to reflect on why they used certain tools and how they felt using them with others, which allowed us to collect data on which tool features fostered inclusive work practices.

Throughout the interviews, participants were also asked to visualize their experiences in a *mapping activity*, similar to [64], in which they sketched how they became involved in the team, major events and times of transition, and what technologies were used and when (e.g. Figures 2, 3, and 4). This helped participants to not only reflect on their experiences, but also helped us identify unique areas to inquire further [74]. For instance, if participants described being friends with their teammates in a maker community before forming a project team, we could inquire about how they first became friends in the community environment and the socio-technical supports provided by the community to form a team. Or if a participant drew that their team heavily relied on text messaging towards the end of the project, we could further inquire about this behavior and how they felt when participating in this practice. Interviews were transcribed immediately following the interview using an online transcription service.

Analysis

We took a qualitative analysis approach [57] by performing two coding cycles where we carefully read and re-read transcripts focusing on issues of technology usage, community, and psychological experiences related to inclusion. We also referred back to printed out photographs of the mapping activity to identify patterns of tool use. We first identified 54 initial codes around technology usage (e.g. "texting for idea sharing"), offline practices (e.g. "encouraging others to participate"), and psychological experiences related to inclusion (e.g. "excitement"; "feeling left out"). These 54 codes were then grouped into 19 higher-level codes by combining those describing psychological experiences with related tool usage or offline practices. For example, "opportunity to fail safely" and "shared document editing tools" were grouped together when an excerpt described a participant feeling more comfortable voicing tenuous ideas in a platform that supported cooperative text editing.

Codes were then further grouped into the three themes around how inclusive teams are formed and continue to function over time based on a theoretical framework of building group inclusion [1]. Levine et al.'s model describes how group inclusion is achieved through processes of evaluation, commitment, and role transition. *Investigation* involves efforts by the newcomer and existing group members to determine the newcomer's involvement will lead to his or her satisfaction and contribution to the group's goals. *Socialization* involves efforts to maintain relationships by attempting to fulfill mutual expectations and expressing positive affect between group members. *Maintenance* involves efforts to meaningfully participate in the group.

These stages of building inclusion informed our final three themes for how independent innovation teams build inclusion in gender diverse teams. For example, the theme, "Communities as Catalyst" describes how creative communities provide opportunities for team members to evaluate each other during early stages of team formation; whereas the theme, "Participation Safety and Socialization" describes how in order to establish positive affect between group members in gender diverse teams, the minority gender needed to have a sense of participation safety. Thirdly, the theme "Regular Opportunities for Participation," describes how participants used collaboration tools to become involved in the project through opportunities to inform the work and decision making processes. We discuss within each theme how technology affordances within these contexts support inclusive practices.

Interview Results

The interview findings describe how members of independent innovation teams develop a team environment for inclusion. We describe how communities act as a catalyst to inclusive team formation, and how teams leverage technologies to encourage opportunities for participation and participation safety—key factors in inclusive environments [2,60].

PID	Age	Gender	Team Size	# Female
1	35	F	4	1
2	31	F	6	2
3	53	M	4	0
4	30	F	6	5
5	35	F	12	4
6	42	F	12	9
7	54	F	6	2
8	56	M	5	0
9	46	F	14	10
10	44	M	8	0
11	31	M	3	1
12	43	M	4	1
13	31	F	15	12
14	49	F	4	3
15	31	F	3	3
16	34	M	3	1
17	56	F	11	5
18	38	M	3	0
19	37	F	6	4
20	33	F	6	4

Table 3: Table of interview participants.

Communities as Catalyst

In alignment with the survey results, participants in inclusive gender diverse teams often reported meeting teammates within a diverse community environment in which they also felt included. However, even though community leaders encouraged people to make connections, the promoted socialization tools often did not support these actions well. For example, certain group communication tools like listservs supported awareness between people with similar interests (P2, P5, P9, P14, P16, P17), but did not necessarily provide the functionality to easily develop stronger connections needed for team formation.

P2 who was a gender minority in her team, described finding project teammates through a discussion on the community listserv. She pitched her project idea to the community-wide email thread, identified many people were interested in the topic, but found it difficult to get the team started in the same online environment:

> *"And of course, as things start to spike, [the community leaders] were like could you stop spamming the listserv with your contact information."* (P2)

After moving the conversation elsewhere, she expressed not knowing who to include in the project formation going forward, concerned that she was excluding people who may have been interested in the project and had only been observing passively until that point.

While technologies facilitated more community-wide communication, many participants preferred meeting others in-person to build trusting professional connections. For instance, P5 described first meeting two male community members in the kitchen of a co-working space. She would later form a startup with them to develop an app that connects local farmers to consumers:

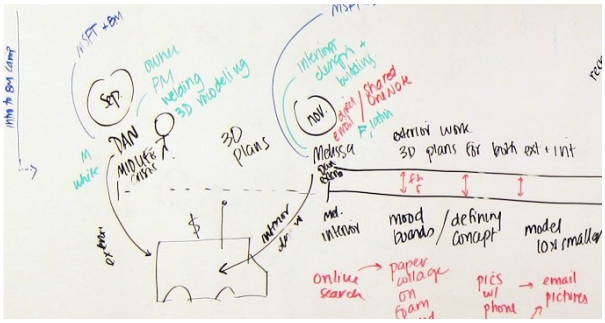

Figure 2: Example from a P1's mapping activity showing how she became involved in her ad-hoc innovation (black) team through a previous community (blue).

"You know, it's those casual meetings that you forget…I jumped out there to get a coffee and we chatted…It was very brief, five minutes, just chatting, made within six sentences a connection…I think I had that level of in-person connection that laid the groundwork for me to feel more comfortable." (P5)

Shared community spaces that encourage socialization sparked interactions between demographically different individuals, which then often led to future collaborations. Other ways participants identified teammates included introductions through existing inter-personal connections (e.g. friend of a friend), and public postings (e.g. Craigslist).

Community involvement also provides a way for people to form bonds over shared values and interests, interpersonal factors that eventually outweigh initial effects of demographic homophily (e.g. same gender) [44,70,71]. For example, one participant who was the only woman and person of color on her team described forming an immediate connection with a team member when she realized they were part of the same art community:

"*You get this edge when you realize someone is from [X community]. It's like you know a lot more about them as soon as you find out because you know they're arty, and they do hard work." (P1)*

In a way, shared community membership provided a vetting process that helped new team members evaluate each other more positively, an initial step to building a foundation for inclusive teams. In Figure 2, P1 drew how she became involved in the independent innovation team (black) by meeting the person at a community event (blue).

One co-working space displayed how they valued their diverse membership through a wall showing individual pictures of all of its members with their name and project interests below. Even though this community had an online directory that provided the same functionality, members found that the physical wall to be more useful when introducing and describing the community to new members because it provided a more visually accessible way to evaluate the community's values and diversity.

In addition to belonging to diverse communities, female participants in particular described the benefits of participating in female-focused communities or communities with role models, such as coding groups for women, to build confidence and persevere in environments where they are perceived as different. Three participants (P11, P17, P10) found these communities to be so important that they went on to start their own groups for others:

"I have a Muslim female group on LinkedIn, so I share a lot of information about coding for women, and I share it in my community for women who may be interested in coding." (P17)

We find that the socio-technical features of communities serve a key role in the formation of gender diverse independent innovation teams by fostering initial communication both online and offline, and highlighting meaningful similarities that may not be initially salient.

Participation Safety and Socialization

While more personal avenues of communication (e.g. phone, video calls, shared spaces) were seen as useful for impression formation, participants who were gender minorities on their team described how these channels sometimes highlighted patterns of social dominance. For instance, P7 who was working in a male-dominant tech start-up described how communicating with the three men on her team through video and phone calls brought to light sexualized topics:

"We pick up a bit of sexism that they're not even aware of…Sort of like flirty jokes. They got on the phone…and they were talking about him putting lotion on his bald head…It was just a vibe. I can't remember exactly. I tend to like freeze and tune it out." (P7)

While describing her experience, P7 drew out a possible a conference-calling interface that would allow her to more easily communicate through written comments and PowerPoint slides (Figure 3) rather than a live discussion, suggesting that she preferred non-verbal forms of communication in particularly uncomfortable situations where she felt her colleagues were acting aggressive or dominant.

These interview findings correlate with our survey data, which revealed how female participants in male-dominated tech projects felt less included the more they used personal communication tools. We highlight that this finding was only apparent in male-dominated tech projects. Women working with men in other areas, such as art and design, did not report feeling particularly excluded, suggesting that certain professional fields may be less supportive of inclusion than others, or more susceptible to stereotype threat.

In contrast, Caucasian male participants who were part of male-dominant tech teams (P3, P8, P12) did not mention being uncomfortable using more personalized communication mediums, but rather preferred it. P8 described that he saw communication technologies as useful for starting a conversation, but preferred in-person meetings *to "read with the*

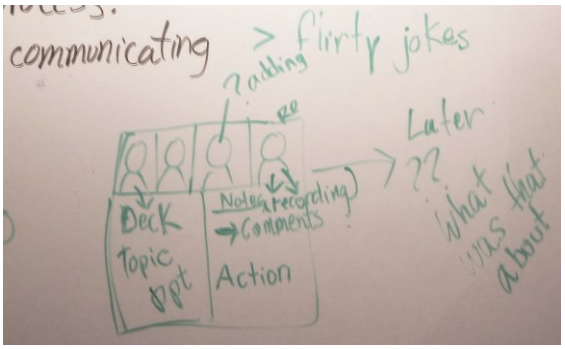

Figure 3: P7 prototypes out a video calling system that allows people on the call to communicate through written comments and shared PowerPoint slides.

body language" because *"if you don't have that, the phone calls are really worthless."* The reliance on body language is beneficial for building trust between people who look and act similar, but may be less supportive of building connections between diverse people who often look different and have different patterns of speaking.

One Caucasian male community leader hoping to increase gender diversity described how he asked some of the female office workers to hang out in the hackerspace to make it more inviting to female newcomers. But, he found that the male participants' conversation topics, like guns, still created a less than inviting atmosphere (P3). Another participant expressed similar frustration when trying to network at a start-up community event:

> *"There's a lot of unconscious self selection out by groups that don't feel welcome...These guys were like, 'Well, we just hired whoever the best person is for the job.' And I'm like, 'You don't realize that your whole like bro thing makes a lot of people not want to work for you or makes them sort of hide themselves personally, which means they're also hiding some of their professional capacity from you because you've created a work environment where they don't feel comfortable.'" (P2)*

Conversely, participants who were part of teams that strived to develop more inclusive environments described using certain communication practices to encourage people to participate in group conversations. For example, P5 described how her team adopted phrases like "Yes, and," which have been shown to encourage group camaraderie and collaborative creativity [33]. Similarly, one participant described how her Japanese colleague had to explain to the team that the other Asian participants did not feel comfortable arguing during team meetings on the phone and in person (P13). In response, one person was designated as meeting facilitator to make sure all voices were heard. Rather than relying on a human resources facilitator or moving employees to a different team during times of conflict, members of independent innovation teams had to self-identify the challenges that hindered diversity and identify new solutions themselves.

Regular Opportunities for Participation

To encourage a continued sense of inclusion beyond team formation, we found tools that supported shared document editing and immediate low-fidelity communication (e.g. texting), made it easier for gender diverse teams to make collaborative decisions and maintain mutual awareness. Rather than creating hierarchies between team members, various participants described how their teams avoided designating power and chose to divide responsibilities based on skillsets. For example, participants explained that "*there wasn't a leader that was designated by an organization"* (P4) and that their collaborations were more *"fluid"* and *"organic"* (P1, P6), suggesting that people involved in independent innovation teams tend to adopt different work mindsets compared to those who work in enterprise teams where there are clear power structures.

This aversion to hierarchy was also reflected in the types of communication and collaboration tools they preferred to use. One female participant who was a project manager described how real-time document editing tools allowed her to communicate more easily with male engineers on her team:

> *"Somehow tracks changes was a fight...It's like this is what I want to say, no this is what I want to say, which is not a conversation, right? Like we can't test things...Whereas with Google Docs, you can just be looking at something and start talking and writing things down and look at it together." (P2)*

Consistent with established work on inclusion [2], participants described how they felt more committed to the team when they had equal opportunities to contribute to project work and decisions.

P6, who was working on a crowdsourced art installation described how her team relied heavily on shared documents to allow all members to co-develop instruction for building their final product. In the mapping activity (Figure 4), she listed using 2-3 different technologies at each stage of the project that allowed all team members to communicate with

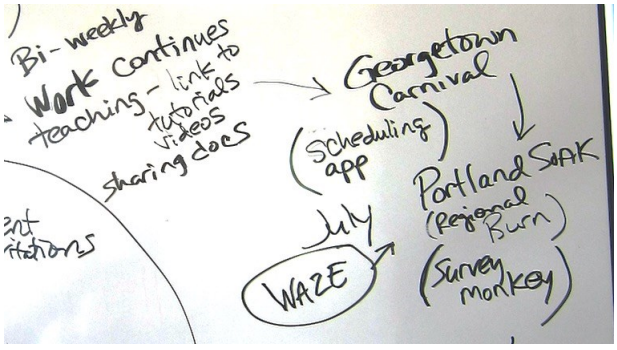

Figure 4: P6 describes how her team used multiple types of communication technologies to keep members of the team aware of what was happening.

each other openly and at any time of day.

Figure 5: Mechanisms and challenges to establishing and sustaining inclusion in independent innovation teams inspired by Levine et al.'s model of developing group inclusion [49].

P11 emphasized that when adopting new collaboration tools, his team found it necessary to establish expectations allowing for equal rather than hierarchical participation:

> *"[One team member] just started assigning us stuff and with no context. And then all of a sudden people were getting more work, so that was bad…It's definitely necessary to create some norms to say, 'Hey, you can't just start as signing people to stuff. You need to have a conversation first.'" (P11)*

While various existing project management tools allow people to assign tasks to team members, participants were wary of using these features fearing that it may cause tension. Tools that supported greater opportunities for participation among all members helped participants feel like they were kept in the loop, reducing team friction.

Overall, we find that creative communities provide an avenue for diverse people to connect over shared project interests, while participation safety and opportunities to participate early on promotes team socialization and maintenance, features needed for group inclusion (See Figure 5) [49].

LIMITATIONS

Before discussing research contributions, we acknowledge limitations to our study. First, survey data on team and community variables was based on self-report. While we cannot make accurate statements about actual team innovation or inclusion, we do not see this as a major problem as it is the individual's perceptions that drive how they feel and act within the team. Furthermore, because teams tended to be less than 10 people, we believed participants could accurately report the gender distribution of teammates. Because only one survey participant reported their gender as non-binary, our findings may not represent the experiences of LGBTQIA people who are also minorities in many innovation settings. We hope that our findings, which mainly describe self-identified female experiences as gender minorities, might still provide useful design implications for forming teams of all genders. Thirdly, interview participants were recruited primarily from one major metropolitan area so that interviews could be in person. Our results may describe a unique innovation culture. However, many of our themes were supported by related work on inclusion and group work practices, suggesting that our findings have implications for independent innovation teams in general. In addition, we also only interview people who have successfully become involved in independent innovation teams. While this biases our sample towards those particularly motivated or supported, our data show that they are still obstacles in managing diversity. We saw the follow-up interviews as a way to identify opportunities for helping those in less supportive environments.

DISCUSSION AND DESIGN IMPLICATIONS

Designing for diversity is difficult due to the sensitive nature of the topic [66]. When dealing with topics that are uncomfortable or psychologically threatening, such as how one's implicit biases affect gender diversity, people are often less receptive to design suggestions that address the problem overtly [14,42,43]. Creating communication and collaboration technologies "to support minorities" is problematic in that it can trigger stereotype threat and a defensive reaction in the dominant population.

Through our survey and interviews, we find that certain team and community practices, in addition to the technologies they use, affect how gender minorities feel when joining and working in male-dominated independent innovation teams. For instance, our quantitative and qualitative findings show that the more a male-dominant team uses "richer" mediums, such as synchronous audio and visual communication channels, there is a higher risk that gender minority participants feel less included. These findings conflict with original work on media richness theory, in which Daft and Lengel argue that "managers will turn to rich media when they deal with the difficult, changing, unpredictable human dimensions of organizations" [23].

Our data show that while richer media allow for greater feedback and social cues, which are typically more useful during

interpersonal communication, they also highlight certain microagressions that often happen to marginalized people [72]. These encounters play a large part in the psychological experience of being part of a team and have been a major reason for why women drop out of male-dominant careers at a higher rate than men [72]. These findings are supported by previous work by Kiesler et al. in which they describe how the affordances of social technologies can mask typically salient features (e.g. gender), making it easier for demographically diverse people to bond over intellectual interests rather than more superficial factors [44,70,71].

However, initially hiding certain traits online, such as gender, between team members only masks the underlying problem rather than addressing it. Motivated by related work on offline interventions to support diversity, tool designers could develop tools that encourage greater awareness of implicit biases in computer-mediated environments. Recent work by Burnett et al. describe a systematic inspection method to evaluate the gender inclusivity of software by prompting the software designers to reflect on how women and men with different technology backgrounds and confidence levels might react to usability issues [17].

Furthermore, various systems have been developed to provide communication-based feedback during group meetings to identify how often teams agreed or disagreed with their colleagues [48] or how dominant certain people are in meetings [45]. Others have created tools to encourage listening in group communication [46]. Encouraging more equal communication between team members can help change engrained communication patterns reflecting social dominance. One could imagine similar systems that would identify how frequently team members respond to or agree with other team members to identify underlying gender-based patterns of attention. Future tools could monitor speaking patterns between minority and majority populations in order to highlight instances where balanced discussions are lacking. For instance, if the tool highlighted that men were significantly more likely to respond positively to comments made by other men, it could signal to them to watch how they encourage others to share their thoughts. Research on speaking time show that men are perceived as more dominant the more they speak, while this effect is significantly less pronounced for women [55]. People who speak more also do not realize the extent to which they are perceived as dominant [55], suggesting that a dominance awareness tool might be useful.

However, such "diversity targeted" tools may not produce the desired affect because people are less likely to respond to overt messages due to the sensitive nature of the topic [42,43]. Furthermore, because there is no overarching company structure to enforce the use of diversity awareness tools, independent innovation teams that elect to start using these tools are more likely already making efforts to support greater gender diversity. Rather, we examine how do we design for gender diversity in teams and communities that are not particularly supportive already.

In their work on designing games for social activism, Kaufman et al. suggest a model of "embedded design" as a way to develop games with a social activism goal (e.g. highlighting implicit biases) without making the game overtly about social activism [42,43]. They suggest three "embedding" strategies: 1) Intermixing- balancing "on-message" and "off-message" content to make the former less threatening, 2) Obfuscating- highlighting a certain genre or purpose to hide the actual intent, and 3) Distancing- using fiction and metaphor to distance players' identities with the game's characters. While these strategies are designed for games, we could apply parts of these principles to the design of communication and collaboration technologies to better support the formation and ongoing work of gender diverse teams.

Designing for Inclusion

In this study, we suggest an "obfuscating" approach by *designing for inclusion* with the underlying primary goal to develop team environments and technologies that support gender diversity. Our goal of designing for inclusion is motivated by previous work and our study findings, which has shown that gender diverse teams are more likely to succeed if they foster inclusive work environments [60]. In addition, related work in HCI on designing gender-inclusive technologies has found that inclusive technologies benefit all users by promoting more user-friendly interfaces and user self-efficacy [15,17].

Compared to previous work on gender-inclusive technologies in HCI [9–11,15,17], we focus less on people's relationship with software, and more on how software's designed affordances influence people's relationship with each other. Therefore, while previous work on gender inclusive technology suggests features that support self-efficacy for using the software itself, like editing program bugs [15], we suggest design implications that support communication self-efficacy, such as promoting confidence to speak up and express one's opinions online. For instance, women with low communication self-efficacy could opt-in for scaffolds on how to communicate more assertively or regularly with teammates. Recently, such communication tools have become adopted among women in email settings, such as a Chrome plug-in that highlights when an email includes the words "sorry," "just," and "I think" [21]. Similarly, if someone wanted to disagree or share an idea during a meeting, but did not know how to affectively interject, such a tool could provide phrases and volume alerts to signal how to appear more assertive.

While women could adopt tools to support their work practice, our study participants primarily called for team-wide tools that could better support equal opportunities for participation in project work. Tools that support co-ownership of documents and projects have been praised for their ability to promote better collaboration through shared awareness [54]. However, participants described the importance of establishing norms when working with these tools, considering that the same tool can be used in multiple different ways by different users [59]. By applying previous work arguing that

non-hierarchical organizations still need structure to be productive and coherent [25], we argue that teams must establish norms when using communication and collaboration technologies to support inclusive work practices. In the future, existing tools could provide tutorials that describe different ways teams could use their tools to promote more balanced communication practices. For instance, P11 described how his team members preferred having a conversation together verbally before putting a task on the project management tool to-do list. Such practices could be suggested in tool tutorials to better support a more open and inclusive work environment among all members.

Communication and collaboration tools could also help teams onboard new members in online discussions. Our findings show that the affordances of various group communication tools, like listserves, make it difficult for new members to become active members if they have low participation self-efficacy. Future group communication tools could notify established members to introduce new members or invite them to participate in a discussion thread. These suggested designs support work on opinion diversity which describes the importance of including minority opinions in innovation work [24].

Similar to previous work on communities of practice [81] and third spaces [61], we find that community culture influences team formation and individual identity. Our interview data show that while group communication tools enable discovery of demographically diverse people with similar interests, they do not make it easy to create more personalized groups that could lead to team formation. Participants asked for easier ways to form and visualize sub-groups that would make it easier for project teams to form in a community discussion environment.

As previously argued by Hinds and Bailey [38], while it is possible to create a separate email thread, these conversations are often difficult to manage because people forget to include certain interested members who then do not have access to previous conversation topics. Similarly, while it is possible to create a separate email list, this often leads to being emailed the same thing multiple times and information overload. Creating community communication tools that make it easier to visualize and organize conversation subgroups could encourage more deep conversations between diverse community members that lead to team formation. This work adds to research on transitioning between levels of cooperative work [5] and recent work on re-designing group communication systems [84].

Participants also found that meeting community members in person better encouraged the socialization opportunities needed to foster team formation. While previous literature describe the benefits of co-located work [13,73] and having shared common spaces [61], our findings suggest that further programming is often needed to motivate connection between people. Tools that help members organize ad-hoc socialization opportunities in shared spaces could distribute planning efforts among community members, thus taking the load off of overworked community managers. Similar to [20], a tool that coordinates on-demand events, a similar tool could signal ad-hoc socialization opportunities by sending out notifications when someone wants to foster an ad-hoc break in a community common area.

While designing for inclusion might be more effective at promoting adoption of diversity-friendly practices, there is still value in interventions that overtly focus on diversity and inclusion. For instance, research on supporting gender and racial minorities in large organizations describe the concept of "counter-spaces" and "safe spaces" as places where groups of minorities come together to provide each other with emotional and professional support [53,69]. Similar to tools coordinating group discussions in MOOCS [18], community-based tools could scaffold conversations and relationship building between gender minorities in innovation work environments by providing regular topics of discussion both online and offline.

HCI researchers have long focused on designing tools that support behaviors like team creativity [33,36,76] and productivity [28,78]. We argue that designing for inclusion to support gender diversity and gender minority experiences will consequently inspire more successful interactions between diverse team members. Based on our quantitative and qualitative data, we suggest five possible avenues in HCI for supporting gender diversity via inclusion at the team and community level: 1) support ad-hoc socialization in community spaces, 2) make it easier to create and manage subgroups that developed from community-wide discussions, 3) scaffold the creation and practice of minority support groups, 4) provide examples of inclusive work practices in online collaboration environments, and 5) track and flag behavior that may lead to less inclusive communication practices.

CONCLUSION

HCI researchers are increasingly interested in developing technologies that support diversity as well as positive experiences of minority and marginalized populations. We contribute to this growing body of work by studying how independent innovation teams create an environment of inclusion with the underlying goal of supporting gender diversity. Through a survey, we found a relationship between technology usage and how people perceived their team as inclusive. Further investigation through interviews describes how a sense of inclusion is developed during diverse team formation and ongoing work, as well as how collaboration tools can both support and hinder inclusive team practices.

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