Community-Based Approaches to Building Peer Support Systems for Work

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Abstract

Independent workers—such as gig workers, online freelancers, or micro-entrepreneurs—take on heightened uncertainty in pursuit of flexible working arrangements. While workers may be independent from organizations' directive control, a decade of ethnographic studies has highlighted how independent workers—who are digitally distributed in space and time—are in fact interdependent on each other for social, emotional, and material support. To augment workers' quests for peer support, scholars and practitioners have designed dozens of intricate sociotechnical systems which foster large-scale, online peer support networks. Yet, solely sociotechnical approaches to building peer support systems have failed to create systems which provide inclusive support for this rapidly growing and diverse workforce. In pursuit of universal user adoption, such approaches often overlook existing peer networks which are entirely offline, and the resulting systems are rarely accessible, or desirable, to workers with limited trust in technology or technology literacy.

This dissertation presents an approach to building community-based peer support systems for work which bridges two disparate bodies of work: sociotechnical system design and participatory action research. To do so, I followed a participatory action protocol to work with community partners who already fostered networks of peer workers to understand if technological interventions could provide supplemental support. In the case that community partners decided to explore technological supplements for peer support, I followed a co-design software protocol to build peer support systems which were driven by local community needs. The outcomes of this approach included not just peer support systems but also educational materials, in-person workshops, and a novel model of on-demand technical support for system on-boarding and maintenance. I illustrated this approach across two multi-year community partnerships with local hubs for independent workers in Pittsburgh, PA. The resulting three peer systems—Hirepeer, Peerdea and Tech Help Desk—facilitated career, professional, and skill development among independent workers.

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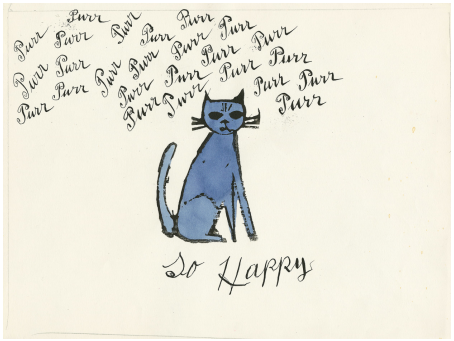

25 Cats Name Sam, and One Blue Pussy
by Andy Warhol

Contents

1 Introduction

Independent work—such as crowd and gig work, online freelancing and micro-entrepreneurship—enables individuals to have control over their work schedules and to be their own boss [259]. These benefits, coupled with the proliferation of online labor platforms, have contributed to the exponential growth of independent work throughout the last decade [19, 148, 209]. Yet, as the independent workforce continues to grow and diversify, workers increasingly share more nuanced experiences of these digital and algorithmically-mediated forms of work. In workers' accounts of independent work, such benefits are often overshadowed by key challenges: heightened economic uncertainty [230, 233, 239], isolation from other workers and community [109, 110], power differentials between workers and platforms [150, 190, 244], and skill barriers [22, 37].

To overcome the challenges of independent work, workers often turn to each other for peer support by creating or joining networks of independent workers. These peer networks exist in-person [236] and online [295], among weak ties (e.g., acquaintances through online labor forums [92]) and strong ties (e.g., local micro-entrepreneur collectives [140]), and are informal [110] and formal [248]. The value of these peer networks rests in peers' shared context of independent work and, by extension, peers' abilities to assuage the uncertainties often entangled in these new forms of work through information sharing and reciprocity [29, 217, 258]. For many workers, these peer networks are critical to thriving—and surviving—in these digitally and algorithmically-mediated forms of independent work.

In light of the rapidly growing amount of digitally-engaged independent workers and the importance of peer support, human-computer interaction scholars developed myriad peer-to-peer systems which bring workers together online for peer mentorship [263], peer feedback on job materials [97, 174], collective action [150, 248], skill acquisition [59, 86], worker reputation building [286], and structuring help requests [145]. For instance, one software system called Hirepeer (detailed in Part I of this dissertation), automated the coordination of online freelancers' peer networks to facilitate peer feedback exchange on job materials [174]. In pursuit of scale, Hirepeer coordinated anonymized peer interactions online, and introduced algorithmic aggregation of feedback to ensure worker impartiality [159]. In doing so, Hirepeer reduced the overhead of providing feedback on job materials and hiring at large scale; both of which were critical to keep pace with the exponential growth of the independent workforce. As with the other dozens of sociotechnical systems described above, Hirepeer's success—providing online freelancers with effective peer feedback—relied on large-scale, online user adoption.

However, a parallel thread in human-computer interaction research calls into question the effectiveness of such sociotechnical systems over the long term for delivering peer support. Human-computer interaction scholars who draw on critical theories of technological development, science and technology studies, and participatory action research have highlighted three challenges with approaches which consider solutions that are solely technological: (1) the tendency to overlook existing, offline networks of workers, (2) the expansion of the digital divide among workers with lower levels of technical literacy, and (3) the loss of relational aspects of peer support when optimizing for large-scale, online adoption.

First, sociotechnical solutions which focus on coordinating online peer networks have the tendency to overlook key peer networks which exist solely offline [110, 236]. A decade of ethnographic work studying independent workers in these new forms of

work revealed intricate peer support networks which were—and continue to be—completely offline [22, 37, 114, 234]. That these peer networks among workers are offline is not a coincidence, but instead is critical for in-person trust building when navigating sensitive issues and information asymmetries and providing emotional support [140]. In some cases, scholars argued these offline peer networks are the key reason why digitally-mediated work is successful in the first place, as trust building occurs more readily in person among workers [110, 235].

A second challenge to a solely technological approach to worker peer support is that the resulting systems are not accessible to workers who had less opportunities or support to improve their technical literacy [78, 83]. Providing systems to workers without additional resources alongside (to support system on-boarding, maintenance, and repair) widens the "digital divide," as mainly digitally-skillful workers derive benefits from such systems [275]. For example, with the Hirepeer system, workers were required to set up the system independent of developer support, and—as with most systems deployment—there was little repair support if something went awry. Moreover, workers had to opt in to an experimental system where they shared de-indentified versions of their resumés with other anonymous workers. Taken together, these steps embodied several implicit assumptions about workers such as—at the highest level—that they trusted an experimental system with their job materials.

Finally, a third challenge of a sociotechnical approach is that the relational aspects of peer support—such as trust building—are deprioritized in order to pursue systems which scale to the masses [81]. To be scale compatible, the systems described above allowed for peer interactions which were momentary and often anonymous (e.g., workers provided quick feedback, but did not engage in conversation, did not know who the other workers were, nor were able to connect with them again in the future [97, 174, 263]). While this can be beneficial in some cases, such as organizing large troves of workers for collective action [150], there are also cases

when relationship building is critical among independent workers such as when intellectual property, platform power dynamics and worker reputation are all on the line. As seen in the offline peer networks, trust between workers may come more easily offline where peers can meet and vet other each other overtime and build meaningful relationships.

In Part II of this dissertation, I addressed these challenges through building community-based peer support systems with independent workers. Throughout two multi-year engagements with a feminist makerspace (Prototype PGH, Oakland, PA [14]) and a co-working center focused on racial equity (Community Forge, Wilkinsburg, PA [13]), I followed a participatory action protocol which emphasized: relationship and trust building between researchers and workers [123], and by extension, understanding workers' candid attitudes towards technology and existing resourceful approaches networks [188]. Then, together with my community partners, we co-designed two systems which provided workers with peer feedback and social support through leveraging existing, offline peer networks. The first system, Tech Help Desk, contributed a novel model of technical support for micro-entrepreneurs from a lean economy[1] which emphasized in-person relationship building through one-to-few tutoring sessions [173]. Tech Help Desk offered—and continues to offer—on-demand technical support at Community Forge every week for over three years, and is now embedded in on-going programming within the community center. The second system, Peerdea, provided a trustworthy virtual space for digitally-engaged entrepreneurs to ask their peers for advice and feedback, general information exchange, and emotional support [177].

By relying on offline relationship building with other micro-entrepreneurs throughout Prototype's annual incubator, Peerdea enabled micro-entrepreneurs to seek peer support asynchronously when in-person meetings were less viable. As with Tech Help

[1] In this dissertation, I use the phrase "lean economies" in order to highlight the resiliency and innovation of residents located in communities with few resources [213], as done in prior work [78].

Desk at Community Forge, Peerdea is formally integrated within Prototype PGH as a supplemental tool for their annual incubator and continues to be a key part of the makerspace's fundraising efforts.

Taking a community-based approach to system design emphasized the existing capabilities and resourcefulness of workers—such as workers' strategies for building their peer networks—which outside researchers and developers are unlikely to be aware of unless they spend time to build relations and learn from workers [22, 188]. By adopting software design methodologies which accounted for unspoken power dynamics in design processes, this ensured that research practices were not extractive in nature [120], and that stakeholders' expertise and tacit knowledge were prioritized in designs (such as how to build the trust required to foster peer networks among workers). This was particularly important when working with independent workers who had a range of digital literacy or experienced technology-based erasure or harm [100]. Finally, following a participatory action protocol deprioritized the role of technological intervention (i.e., there was no assumption that co-designed solutions needed to incorporate certain technologies). As a result, this allowed for a range of technological complexity in the resulting interventions: Peerdea—a smartphone application for both iOS and Android—provided a technological supplement to Prototype PGH's annual incubator, while Tech Help Desk—a low-tech social support service—was better suited for Community Forge's needs for weekly in-person trust building.

1.1 Dissertation Contributions

This dissertation contributes the following:

1. An approach to develop community-based peer support systems which bridged participatory action and system design through multi-year engagements with local community partners. The resulting peer support systems were both online and offline, extended existing relationships between work-

ers, and were driven by the community needs of two partners: a feminist makerspace (Prototype PGH in Oakland, PA) and a co-working and resource center (Community Forge in Wilkinsburg, PA).

2. Novel algorithms and interfaces for algorithmic interpretability and novel interface designs for peer support systems in work. Alongside these technological contributions, this dissertation contributes educational materials for workers' technical skill acquisition, a novel model of on-demand technical support for independent workers, grant writing with community partners, and in-person workshops which complemented peer support systems to provide supplemental support.

3. A longitudinal and qualitative understanding of independent workers' socio-emotional, technological, and material challenges when engaging in alternative forms of work not limited to online crowdworkers and freelancers but also micro-entrepreneurs.

1.2 Thesis Statement

To create sociotechnical systems which provide inclusive support for independent workers, researchers should invest in relationships with local community partners who are already supporting independent workers, and, together, co-design technological interventions that are congruent with community objectives.

1.3 Dissertation Impact

Together, 74 independent workers co-designed Tech Help Desk and Peerdea and leveraged these systems for peer support. Another 331 independent workers used Hirepeer for peer support throughout user testing sessions and deployment. These independent workers created either physical goods or provided in-person or digital services including graphic design, digital marketing, custom gift

baskets, poetry publishing, ethically-sourced coffee roasting, local recycling, inclusive beauty products, queer-affirming massage therapy, coding boot camp for women, school transportation and daycare for children. In addition, through leading research collaborations with Etsy and Instagram, I produced actionable design principles—which have been implemented on both the Instagram and Etsy platforms with millions of users—such as platform interface designs and messaging for workers' to bolster their reputation whilst sharing unfinished work [171, 175]. All the while, my research remained continuously embedded in the communities of workers with whom I collaborate and serve [173, 177].

1.4 Dissertation Overview

In this dissertation overview, I provide a brief description of each dissertation chapter and then detail how each chapter informed my overall dissertation contributions.

1.5 Part I: Building Peer Support Systems for Independent Workers

Chapter 3 of my dissertation asked: can independent workers, specifically online freelancers, assess each others' job materials to provide effective feedback and to identify qualified candidates? By following a traditional human-centered design approach [222], I developed Hirepeer which introduced new algorithms [159] to enable peer-assessed hiring among online freelancers by resolving conflicts of interest [174].[2] Workers applying for an online task assessed each other for who was the best fit for the job, providing peer feedback on each others' job materials along the way through comparative peer review [49]. Hirepeer's impartial aggregation of workers' pairwise comparisons ensured no conflicts of interest. Through two between-subjects experiments and one pilot study with 331 online crowd workers and freelancers (Mturk.com and

[2]The published versions of this work can be found in [174] and [159].

Upwork.com), I found impartial peer assessment was highly accurate, only resulting in an 8% decrease of accuracy [174]. In addition, I found peer assessment provided freelancers with real-time, high-quality feedback on their job materials by harnessing the domain expertise of job applicants. Ultimately, Hirepeer's impartial peer assessment paved the way for high-quality peer feedback on online freelancer job materials by coordinating a critical mass among workers with similar expertise.

To successfully provide peer feedback on freelancers' job materials, Hirepeer's algorithmic coordination of users resulted in workers exchanging momentary and indirect interactions with their peers as they reviewed each others' de-identified job materials. I argue that while Hirepeer addressed some uncertainties of independent work (e.g., closing a critical feedback loop on employment considerations), Hirepeer perpetuated other uncertainties of independent work (e.g., interacting with unknown actors). Such design decisions—to pursue large scale and deprioritize relationship building—are common among the many state-of-the-art peer systems for independent workers. Therefore, to gain a rich understanding of the myriad uncertainties independent workers faced, I began a longitudinal qualitative analysis of online freelancer experiences over three years (detailed in Chapter 4). Alongside, I began to build community partnerships with existing non-profits with positive reputations for supporting diversity in independent work: I joined a feminist makerspace, Prototype PGH [14], as a member in 2018, and I joined an entrepreneurial hub, Community Forge [13], as a member in 2019. Ultimately, both of these memberships developed into mutually beneficial research partnerships, which are detailed in Chapters 5 and 6.

In Chapter 4, I report a longitudinal, qualitative study which involved semi-structured interviews with a set of 20 online freelancers at two time periods, three years apart (2017 and 2020) who used popular online labor platforms such as Upwork.com and Fiverr.com (software developers, writers, data entry clerks,

marketing specialists, graphic designers) [37].[3] We found that online freelancing provided unique career development opportunities over a longer period of time such as entrepreneurial training and reputation, skills transfer and career exploration and transition. However, long-term engagement with online freelancing involved a set of financial, emotional, relational, and reputational burdens that represented the unique overhead of maintaining an online freelancing career, as compared to a traditional career in knowledge work. One strategy workers developed to resourcefully address this overhead included how online freelancers' used their offline jobs (they often had multiple forms of employment) to seek social support, skill training, and wage negotiation support among colleagues which freelancers then used in online jobs.

Chapter 4's findings folded into a larger ethnographic discourse on the role of offline peer networks created by independent workers, particularly by contributing an analysis focused on highly-skilled online freelancers' long-term pursuits. That these peer networks among workers are offline is not a coincidence, but instead is critical for in-person trust building when navigating sensitive issues and information asymmetries and providing emotional support [140]. To better understand and further support workers' existing strategies and networks, such as the intertwining of online and offline networks, human-computer interaction scholars emphasized the importance of finding and collaborating with existing organizations or non-profits which already amplify independent worker voices [22]. Therefore, viewing community through a proximate lens [53], I considered existing spaces where independent workers gathered in Pittsburgh, such as Pittsburgh's many community sites dedicated to digitally-engaged local entrepreneurs.

[3]The published version of this work can be found in *Blaising, A., Kotturi, Y., Kulkarni, C., & Dabbish, L. (2021). Making it work, or not: A longitudinal study of career trajectories among online freelancers. Proceedings of the ACM on Human-Computer Interaction.*

1.6 Part II: Co-Designing Peer Support Systems with Independent Workers

In Chapter 5, I followed a participatory action research protocol and collaborated with various stakeholders at an entrepreneurial co-working space, Community Forge, to investigate technical skill development for digitally-engaged local entrepreneurs—entrepreneurs who primarily target their local economy but rely on myriad digital tools to do so successfully.[4] Together, we created a novel model of on-going technical service for entrepreneurs called "Tech Help Desk", where local engineering students, postdoctoral associates, faculty and community members provided weekly technical support, in-person and remotely [173]. Our model for technical assistance was strategic, in how it is designed to fit the context of local entrepreneurs, and responsive, in how it prioritizes emergent needs. From our engagements with 19 entrepreneurs and support personnel, we reflected on the challenges with existing technology support for local entrepreneurs from a lean economy. This chapter highlights the importance of ensuring technological support services can adapt based on entrepreneurs' ever-evolving priorities, preferences and constraints. Furthermore, we find technological support services should maintain broad technical support for entrepreneurs' long tail of computing challenges [173]. Together with Tech Help Desk, entrepreneurs addressed 61 distinct computing challenges.

Tech Help Desk mitigated additional uncertainties of independent work by adapting to entrepreneurs' need for temporal and spatial flexibility and by prioritizing trust and relationship building between community members and researchers [188]. Taking a participatory approach which deprioritized technological innovation was critical as the local entrepreneurs we worked with had already concocted resourceful strategies for addressing their technical needs. They used a large array of computing tools for

[4]The published version of this work can be found in *Kotturi, Yasmine, et al."Tech Help Desk: Support for Local Entrepreneurs Addressing the Long Tail of Computing Challenges." CHI Conference on Human Factors in Computing Systems.* [173].

business tasks (adding yet another system was counterintuitive). Moreover, a participatory action protocol ensured the collaboration provided immediate value for community stakeholders, and was not extractive in nature. This was particularly important given the tenuous precedent Carnegie Mellon University had set through poor relationship building with Pittsburgh residents [8]. Alongside my work with Community Forge, I explored a collaboration with another community partner: a feminist makerspace in Oakland, PA which primarily focused on equity in technology and entrepreneurship.

In Chapter 6, I followed a co-design protocol with a local feminist makerspace to investigate a peer support system for creative entrepreneurs who primarily focused on making physical goods. Building on Prototype's ethos that everything is a prototype and feedback is critical to success, we began a co-design process through a series of design workshops with 26 local entrepreneurs which investigated the benefits and challenges feedback exchange online among entrepreneurs [171].[5] Then, we integrated findings from the workshop within an initial software prototype, and proceeded to co-design a mobile application, Peerdea, throughout a three-year collaboration with Prototype [177]. Throughout 2020-2022, Peerdea was embedded in Prototype's annual incubator with 30 entrepreneurs where we continuously integrated entrepreneurs' requests into Peerdea's design. Because Peerdea leveraged existing relationships and in-person relationship building among users, Peerdea was used as a trustworthy virtual space for digitally-engaged entrepreneurs to ask for advice and feedback, general information exchange, as well provide emotional support. Peerdea's virtual contribution to the incubator enabled asynchronous peer interactions online when busy schedules prevented synchronous discussions or when in-person meetings were not desirable (such as when familial duties took priority) nor feasible (such as during the COVID-19 pandemic). Hosting in-person

[5] The published versions of this work can be found in [171] and [177].

workshops alongside provided opportunities for system maintenance and repair.

Prototype PGH provided a physical meeting space for digitally-engaged entrepreneurs to seek a community of practice [285], establish a sense of place, and engage in situated learning practices such as legitimate peripheral participation [283]; all which are especially important to entrepreneurs engaged in open-ended work. But, when schedules picked up as they inevitably did for busy entrepreneurs or when in-person meetings were otherwise not available, Prototype desired a virtual accompaniment to their makerspace, specifically for entrepreneurs participating in the annual incubator. To mitigate challenges throughout the co-design process due to power differentials, we rapidly integrated entrepreneurs' request to showcase system malleability, did not push usage of the system (but instead focused on differing levels of engagement and how entrepreneurs appropriated the application), and we showed up in-person when permitted for co-working and troubleshooting support. Taken together, Peerdea and Tech Help Desk required multi-year relationships built on mutual trust and clear expectations. In the following section, I look towards the challenges of sustaining multi-year relationships over the long term.

1.7 Part III: Conclusion and Future Work

To conclude, I consider directions for future work of community-based approaches to building peer support systems. Specifically, I outline how future work may explore the challenges to ensuring that community-based interventions—such as Peerdea and Tech Help Desk—are sustained over the long term. To do so, I consider the tensions around sustaining community-based work such as short student tenures, grant expiration, ownership (who owns the outcomes of community-based work like Peerdea and Tech Help Desk?), and responding to evolving community needs overtime. Finally, I close with questions for future work raised in this dissertation at the intersection of community-based approaches, software design and the "future of work".

2 Related Work and Theory

2.1 The "Future of Work"

Is the "Future of Work", a once distant utopia, here? Today, robots clean hotel rooms based on algorithmically-assigned priority queues which are meant to lessen monotony and manual labor. Online freelance marketplaces enable organizations to outsource to highly-skilled workers on-demand [181], while also enabling workers to be their own boss and work anywhere, at any time [259]. Individuals without formal business training can transform side hustles into small businesses overnight using intelligent software tools to create, market and sell their goods online [280].

This dissertation focuses on one such important shift in work: the rapid rise of alternative working arrangements [181, 209], broadly defined as activity undertaken for another party in exchange for compensation where no organization has directive control over workers [52]. While alternative work arrangements have been a staple throughout United States' labor history, the recent rise of such arrangements is of important note: from 10.7% in 2005 to 15.8% in 2015 [164]. Growth has been projected to be exponential in the coming decades, such that by 2027, independent workers will comprise 50% of the United States workforce [19, 148]. Poorly understood by traditional measures of the labor economy due to nuances in work type and rapid technological change [162, 182], this sector is referred to by a plethora of names: "gig economy" [204], "digital economy" [265], "platform economy"' [168], "sharing economy" [262], and more [124]. For instance, gig workers use two-sided online marketplaces to connect with customers requesting

on-demand rides or at-home care services [57], online freelancers use platforms to find complex work around the world such as graphic design or mobile development [133], crowd workers fill in the gaps of automation through micro-tasks such as image labeling [109], and micro-entrepreneurs rely on myriad digital tools to plan, create, market and sell their goods [78, 182].

In my dissertation, I use "independent workers" [148] to collectively refer to the various workers described above with the ultimate goal to make salient the common threads which warrant special attention across all. For instance, the independent workers described–regardless if their work is completed online or in-person or if the outcomes are physical goods or services–are intertwined by their use of, and reliance on, digital tools and platforms to find, plan, and complete their work [182]. This "digitization of labor" [17] supports temporal and spatial distribution of independent workers, and the resulting flexibility is appealing to workers who want, or need, control over their work schedules [57]. Without organizations to bring independent workers together in space or time, workers operate in isolation by default (currently, online platforms rarely provide features where workers can connect with one another on platform [110, 114, 295]). In lieu of organizational control, platforms which mediate labor rely on algorithmic control to manage independent workers at large scale [190], such as through automated worker reputation aggregation and ranking [132] and automated matching mechanisms between workers and clients [134].

In the remainder of this related work section, I describe the heightened uncertainty independent workers navigate and the various software systems human-computer interaction scholars and practitioners have built to address workers' uncertainties (such as by connecting workers with their peers online). Then, I discuss why peers are uniquely positioned to provide support to other independent workers. Finally, I detail how community-based research with independent workers may address issues of inequity in system design.

2.2 Handling Uncertainty in Independent Work

Scholars who prioritize workers' perspectives in independent work (as opposed to solely emphasizing platform or employer objectives) discuss how labor platforms and tools offload risk onto workers, sometimes referred to as the "precarity" of digitally-engaged independent work [230, 233, 239]. Examples of precarity include how independent workers must constantly track and respond to market volatility [170], secure and manage health and retirement benefits [94], incessantly update their skill set to stay competitive [22], all the while outpacing automation [278]. When issues arise, such as technical glitches causing digital payment delays, workers ultimately have to fix issues themselves [161]. Alongside, platforms' continue to reckon with gender and racial discrimination on their platforms [89, 98, 119], as well as other ethical concerns such as low pay, scams, and worker invisibility and objectification [253]. Taken together, such problems ultimately only further the trials and tribulations of independent workers. Moreover, labor protection laws often overlook independent workers due to the "odd mix of independence from any single employer and dependency on a web-based platform" [109].

Throughout the last decade, human-computer interaction scholars have prioritized efforts to deepen academia's understanding of independent work, and ultimately the public and policy makers at large [67]. Within this short period of time, many have conducted ethnographic and qualitative analyses of independent work, which surfaced many of the challenges to independent work (and counteracted initial rosy accounts) [109, 110, 114, 115, 190, 234, 294]. Ultimately, one theme in this research was how independent workers leveraged their peers in order to mitigate risk in independent work. In other words, independent workers are often interdependent on each other. This is especially noteworthy, as labor platforms provide limited to no peer communication features (with the expectation of the occasional monitored forum).

To start, Gupta and Gray et al. detailed the length that crowd workers went to in order to facilitate an informal social network

among themselves [114], citing a five year anthropology study which included 200 interviews and thousands of survey responses from crowdworkers [110]. Qadri's analysis of delivery drivers in Jakarta, Indonesia illuminated the informal collectives delivery drivers created through in-person meet ups [235]. Workers mobilized these collectives in order to advocate for driver issues and provide each other with support (e.g., sharing safety equipment during COVID-19 pandemic) [234]. Yao et al. found that gig workers connected online through social media platforms; while some shared information and strategies to improve their worker experience, others kept information confidential in order to maintain a competitive edge [294]. Lee et al. found how such information sharing among workers changed depending on whether or not the social media group was moderated by platform employees [190]. If a social media group was moderated by platforms, ride-share drivers were hesitant to post complaints or problems as they felt this could cause them trouble later given power differentials (i.e., platforms shutting off their worker profile without explanation).

Ultimately, this dissertation builds on this body of work in two key ways. First, this dissertation's longitudinal studies build on the larger ethnographic discourse on the role of offline peer networks created by independent workers. Particularly, this dissertation contributes an analysis focused on highly-skilled online freelancers' and micro-entrepreneurs. Second, this dissertation contributes three peer systems which address various uncertainties which independent workers face (e.g., insight into why job applications were unsuccessful, design feedback on unfinished products, and on-demand technical support for broad computing issues).

2.3 Sociotechnical Systems to Support Independent Workers

To address the challenges of independent work surfaced in these accounts—power differentials, isolation, lack of training—many systems have been created by human-computer interaction schol-

ars. Given strong power differentials between platforms and independent workers, and friction within workers' self-organizing efforts, human-computer interaction scholars have explored designing systems for independent worker collective action [150, 248], worker-driven reputation [286], and worker well-being [191]. For instance, citing the prominent issues of unfair treatment of workers by employers (i.e. "requesters") on labor platforms (such as abominably low pay, or not paying workers for completing a task while still keeping the work), Irani and Silberman built Turkopticon, a platform for workers to collectively review requesters [150]. Through almost 10 years of deployment to date, Turkopticon has become a core part of crowd workers' ecology of support [151].

Another system which supports collective action, Dynamo, particularly responded to the challenges workers experience when attempting to self-organize (such as in the above scenario where workers' fear of platform retaliation silenced them from raising concerns) [248]. To do so, Dynamo structured collective action efforts to maintain momentum by implementing deadlines, encouraging experimentation to move issues forward, and making it easy to undo such experimental progress in the case that there was no consensus. Importantly, to arrive at their final system implementation, Salehi et al. described the co-design protocol they followed, where crowd workers themselves were able to suggest and veto features. An alternative approach to calibrate power differentials between workers and platforms was presented in the Crowd Guilds system, which enabled workers to peer assess each other to determine worker reputation (rather than solely requesters determining worker reputation) [286].

In addition to power differentials, several sociotechnical systems supported career and professional development for independent workers through online feedback exchange and mentoring, automated career suggestions, and skill training [32, 59, 80, 85, 86, 97, 145, 170, 263, 296]. Noting that the majority of crowd feedback systems provided feedback on a single project, Foong et al.'s CrowdFolio aimed to support feedback on an online free-

lancers' entire portfolio [97]. To do so, online freelancers focused on graphic design uploaded links to their online portfolio to the web application, and crowd workers provided holistic feedback such as overall visual attractiveness and perceived target audiences. To respond to the incessant need for independent workers to update their skill set to stay competitive, Kokkodis and Ipeirotis presented a personalized and adaptive career development "robo-advisor" which used market information to identify current trends and project future wages and to provide "demand-aware career path recommendations" [170]. Through a retrospective analysis on just under two million job applications, they showed how if contractors behaved as they "should" then such career guidance should increase overall wages and marketplace revenue.

To facilitate transitions between current and desired employment, DreamGigs, provided step-by-step guidance through a process of selecting which skills they would need to acquire and connecting them to job calls where they could practice such skills [80]. In doing so, DreamGigs responded to calls to design technology to support low-income job seekers by making it mobile friendly, providing direct support, and following a protocol for self-empowerment [76] and participatory design [79].

To support the acquisition of specific skills, human-computer interaction scholars created several systems [32, 59, 263]. For instance, Crowd Coach was a browser plugin which connects workers with peer workers to receive coaching while on the job. To do so, peers' advice was captured ahead of time in small "coaching snippets"—less than 100 characters—and these snippets were labeled with certain types of tasks [59]. When a worker performed a related task, they were prompted to view a coaching snippet. On the other hand, Scopist, a JavaScript application took a top-down approach by implementing a skill ladder within a series of audio-transcription tasks [32]. Workers were guided through a process of using a QWERTY keyboard to learn stenotype, ultimately improving their abilities over time while simultaneously completing tasks.

The "Socio-Technical Gap" within the Independent Workforce

While many of the sociotechnical system interventions described above focused on universal adoption, other human-computer interaction scholars focused on how, for some communities, such interventions may be less effective or even harmful. For instance, Dillahunt et al., challenged a widely sung narrative that online technologies *enable* entrepreneurship [78]. They found that for entrepreneurs from a lean economy—an economy where resilience and resourcefulness resound in order to satisfy needs that other economies address with plentiful resources [213]—entrepreneurial platforms and tools actually exacerbated what Ackerman referred to as the "socio-technical gap" [16] and argued that without conscious effort to support workers with diverse backgrounds, such tools will continue to contribute to socio-economic divides. Prompted by this tension, Dillahunt et al. presented a thought-provoking question: "If digital tools alone are insufficient for a progressive boost to less advantaged groups, what else is required?"

In response, several scholars have addressed this question in their work. For instance, Hui et al. provided a rigorous analysis of necessity-driven entrepreneurs who emphasized the importance of building trust in-person, then leveraging online tools like social media platforms to continue to build relationships [142]. Through multi-year studies of micro-entrepreneurs in Accra, Ghana and Detroit, Michigan, Avle et al. described the "additional labors" required in order to acquire the digital skills amidst low-resource urban environments [22]. They found that in both cities entrepreneurs sought localized support such as joining co-working spaces or accelerators, but given colonial and racial histories which continued to shape economic opportunities, participation in these spaces added yet another "additional labor" of navigating cultural and class boundaries. Ultimately, the authors called for an assets-based community development framing when working with independent workers from lean economies [213].

This dissertation builds on this line of work in two key ways. First, this dissertation extends sociotechnical system design ap-

proaches to incorporate community-based and participatory design methodologies when building peer support systems with independent workers. Second, taking up Dillahunt et al.'s call to push past solely technical contributions, this dissertation considers what other contributions are required alongside technological interventions within the context of peer support among independent workers. For instance, this dissertation contributes a novel model of on-demand technical assistance, educational materials, co-writing grants, and in-person workshops for system repair and relationship building.

2.4 The Unique Value of Peer Support

Many of the sociotechnical systems described thus far rely on peer networks of independent workers in order to mitigate the uncertainties of independent work. There are several key reasons why peer support is uniquely valuable for workers, as opposed to other forms of support such as familial or managerial support. First, by definition, peers are united through a shared context– such as age, or employment level or type, or identity [29, 217, 258]. While family or friend support may be more available at the start of an independent career [110, 118], they might not necessary understand the trials and tribulations of independent work, and this disconnect can lead to misunderstandings and frustrations. For example, when micro-entrepreneurs sought advice from close family members on their business endeavors, they sometimes were confronted with resistance to their seemingly risky pursuit or were otherwise discouraged by their family's response [171]. In contrast, peers' shared context helps to facilitate perspective-taking.

When peers are available, the shared context they have gives them the upper-hand when providing advice or feedback to each other given their relevant domain expertise. For instance, in open-ended or creative domains, peer workers were able to provide more accurate idea forecasting than managerial assessment or self-assessment [30]. That is, when peers were presented with a set of ideas generated by other workers, peers were able to more

successfully predict which ideas would have more market success than both managerial and self-predictions. Given their relevant domain expertise, peers' sweet spot of shared context—yet distance to the idea origin as compared to the creator—led to more accurate advice than others. This is especially relevant in the context of independent work because workers, by definition, do not have managerial oversight.

Finally, peer support also provides a human-friendly solution to issues of scale. For instance, rather than relying on solely machine assessment, peer assessment is often used in large-scale classes (such as massive online open courses) in order to provide high quality feedback on open-ended work [183, 269]. Even when peers are novices, carefully designed scaffolds and rubrics can help peers to generate high quality feedback [49]. Ultimately, peers are a valuable resource in systems of large scale, whether a classroom or an online labor platform [174].

Many study the value of peers through the lens of network effects or social network analysis: as the size of the network grows, the value of the network also grows [108, 252]. For independent workers, large peer networks help create critical social capital which can connect workers with potential customers or investors. For instance, for novice entrepreneurs, large social media followings were correlated with small-venture success [146]. Sometimes these large peer networks are not just beneficial, but also critical to worker success, such as in the case of collective action, where critical mass is required for worker success [248]. In order to better coordinate peers at large scale, scholars have introduced emergent theories such as distributed mentorship [50], distributed apprenticeship [143] and distributed critique [178]. Ultimately, these frameworks describe best practices for coordinating peers online where they may not necessarily know each other such as leveraging asynchronicity, aggregation, and affect of peer interactions.

However, not all scenarios of peer support benefit from large-scale and online interactions among acquaintances. In fact, such an approach may actually do the opposite of providing support

in cases where trust is needed in order to build peer-to-peer relationships. In the case of independent workers, peers may have confidential ideas or intellectual property they wish to ask for feedback on from peers, to solicit advice on an issue they are having with a customer or client. In these cases, theories which emphasize small-scale, side-by-side relationship building among peers may be more relevant. For instance, communities of practices, a descriptive theory, emphasizes the importance of peer support through in-person interaction, especially in the context of creative work where legitimate peripheral participation fosters informal learning [186]. Communities of practice can be found among makerspaces which emphasize community building through co-working sessions and incubators for entrepreneurs [144]. This dissertation builds on these works by centering the importance of trust among peer networks of independent workers, especially among underrepresented workers. In addition, this dissertation extends related work on peer support system design by taking a community-based approach, as detailed in the following section.

2.5 Community-Based Research Approaches

Community-based design research (also referred to community-based participatory research [279], community-based collaborative design [120] and community-based participatory design [246]) is intended to engage community members and researchers in collaboration to conduct research and derive solutions based on the community ideas, wants, and needs, and to do so in a way which ensures power dynamics across stakeholders are kept in check. These various terms together are united in their prioritization of the "community", often defined by a shared geographic location and thus a "proximate community" [53]. As opposed to participatory design set in the workplace where organizational goals and commercial pursuits indicate clear leaders and objectives [39], local communities united by geography comprise mixes of motivations, goals, and histories [188].

Part of the promise of community-based approaches is that the

solutions derived are meant to be more effective than the alternative solutions resulting from a professionally-led human-centered design process. This is the case for several reasons: community-based approaches hearken community wisdom and encourage alternative types of knowledge not traditionally surfaced in design processes [188], such knowledge is able to deeply shape a design process given a heightened attention to power dynamics across stakeholders [43], and as a result, solutions are finely attuned to a community's needs. In addition, when community-based approaches are done well, they can empower communities by supporting community ownership over any design outcomes [69]. This dissertation builds on community-based research approaches by applying this approach to software development for peer support among independent workers. In doing so, this dissertation contributed details of how to apply community-based approaches when working with underrepresented independent workers seeking peer support; for instance, emphasizing trust and relationship building between workers was critical, as was between workers and researchers. Moreover, the dissertation builds on community-based research approaches by detailing the challenges of sustaining community-based work over the long term.

Community Partnerships in Pittsburgh, PA

This dissertation work discusses two multi-year community partnerships: the first is a feminist makerspace with the mission of gender and racial equity in entrepreneurship based in North Oakland, PA called Prototype PGH [14] (See Figure 6.3) and the second is a co-working space and community hub for local entrepreneurs based in Wilkinsburg, PA called Community Forge [13] (See Figure 5.1). In this section, I provide a brief overview of the local context in which these partnerships took place.

Pittsburgh, PA Pittsburgh is a small city located in Western Pennsylvania with a population of just over 300,000 [48]. In attempts to overcome the post-industrial blight the region experiences, the

City of Pittsburgh continues to foster a culture of entrepreneurship through various events, grants, local partnerships with universities and co-working spaces [3]. While local attempts have been made to foster inclusivity within these circles, Pittsburgh continues to struggle with gender and racial equality in entrepreneurship and independent work. For instance, in 2021, Pittsburgh, PA was considered to be one of the U.S.'s "Apartheid Cities" [7], as the structures of power within the city continue to perpetuate systemic racial inequality and injustice [211].

Prototype PGH in North Oakland, PA

North Oakland, PA Oakland is a neighborhood in Pittsburgh, PA where the University of Pittsburgh, Carnegie Mellon University, several museums, and other landmarks are all located [12]. North Oakland spans the space between the commercial and academic environment of Downtown Oakland with the working class residential setting of the surrounding neighborhoods towards the north.

Prototype PGH Founded in 2016, Prototype PGH's mission is to build gender and racial equity in tech and entrepreneurship by "providing affordable access to high tech tools and equipment, offering workshops that prioritize the experiences of marginalized communities, and cultivating a professional support network" [14]. The makerspace is located Pittsburgh's Oakland neighborhood. The space hosts co-working, setups, makerspace equipment such as a laser cutter, 3D printer, and vinyl cutter, and workshops such as body affirming tailoring and salary negotiation. Prototype PGH serves as a hub for local entrepreneurs, through informal meetups and the annual incubator program for women and people with marginalized gender identities. Since its founding in 2016, the makerspace's team members have spent years building strong relationships with local entrepreneurs. The makerspace's ethos, that "everything is a prototype" showcased the importance of iter-

ation for entrepreneurial and creative success.

Community Forge in Wilkinsburg, PA

Wilkinsburg, PA Wilkinsburg, PA is a borough of Allegheny County, PA. The population of Wilkinsburg, PA is roughly 68% Black and 35% of people are living at or below the poverty line [11]. Wilkinsburg, PA immediately borders but is not part of Pittsburgh, PA, and it is one of the many unincorporated municipalities that acutely struggle with resource deprivation and long-term disinvestment [1].

Community Forge Founded in 2017, Community Forge is a former elementary school re-purposed into a space that hosts mixed programming geared towards developing a more equitable economy for Wilkinsburg, PA and the Greater Pittsburgh, PA region (Figure 5.1). Towards this goal, Community Forge provides financial resources, jobs, job training, business development, youth empowerment programs (e.g., courses, summer camps, hands-on-learning), and community outreach events (e.g., food and supply giveaways, music and movie nights, polling location). Community Forge's business development resources include: coaching and professional service referrals, technical assistance, networking opportunities, financial support, and affordable office rentals (repurposed classrooms with co-working and individual office space, Figure 5.1B). Community Forge works with roughly 50 local businesses each year through a variety of programs where 95% of the businesses are Black-owned, approximately 90% of entrepreneurs do not have a college degree, and 80% are first-time entrepreneurs. To spread information about resources available within the space, Community Forge relies on word-of-mouth and social media, as well as working with existing organizations in Wilkinsburg, PA and Pittsburgh, PA which support entrepreneurs. Community Forge also hosts quarterly tenant mixers, where the entrepreneurs renting space at Community Forge can mingle, enjoy free food, share

updates and learn about any Community Forge announcements.

Part I

Building Peer Support Systems for Independent Workers

Part I Summary

In the first chapter of Part I (Chapter 3), I present a sociotechnical system for peer support, called Hirepeer, which provided peer feedback on independent worker job materials. To design Hirepeer, I followed a traditional human-centered design approach: I created a prototype, solicited user feedback, and iterated as needed to address my original research question. To provide peer feedback, Hirepeer leveraged online peer networks and relied on coordinating a critical mass of workers. As common with a sociotechnical approach, several assumptions were made in pursuit of large-scale user adoption such as that workers were comfortable interacting with anonymized and unknown workers. I argue that while novel in its pursuit to coordinate peer workers on-demand, structure peer critique, and aggregate impartial peer assessments, Hirepeer furthered the uncertainties of digitized work by deprioritizing the relational aspects of peer support—common in sociotechnical approaches to peer support systems.

Therefore, in the next chapter (Chapter 4), I report a longitudinal qualitative analysis of online freelancer experiences over three years across several platforms, where we investigated workers' uncertainties overlooked by a solely quantitative approach. Chapter 4's findings folded into a larger ethnographic discourse on the role of offline peer networks created by independent workers, particularly by contributing an analysis focused on highly-skilled online freelancers' long-term pursuits. That these peer networks among workers were offline was not a coincidence, but instead was critical for in-person trust building when navigating sensitive issues and information asymmetries and providing emotional support.

3 Building Peer Support Systems for Independent Workers

3.1 Overview

Chapter 3 of my dissertation asked: can independent workers, specifically online freelancers, assess each others' job materials to provide effective feedback and to identify qualified candidates? By following a traditional human-centered design approach [222], I developed Hirepeer which introduced new algorithms [159] to enable peer-assessed hiring among online freelancers by resolving conflicts of interest [174].[1] Workers applying for an online task assessed each other for who was the best fit for the job, providing peer feedback on each others' job materials along the way through comparative peer review [49]. Hirepeer's impartial aggregation of workers' pairwise comparisons ensured no conflicts of interest. Through two between-subjects experiments and one pilot study with 331 online crowd workers and freelancers (Mturk.com and Upwork.com), I found impartial peer assessment was highly accurate, only resulting in an 8% decrease of accuracy [174]. In addition, I found peer assessment provided freelancers with real-time, high-quality feedback on their job materials by harnessing the domain expertise of job applicants. Ultimately, Hirepeer's impartial peer assessment paved the way for high-quality peer feedback on online freelancer job materials by coordinating a critical mass among workers with similar expertise.

[1] The published versions of this work can be found in [174] and [159].

3.2 Introduction

Perhaps the most widely adopted method today to address the large costs of screening applicants is reputation systems. These systems aggregate a candidate's prior task performance, as assessed by past employers, into a score. Although reputation systems are widely adopted by platforms, they bring with them their own set of challenges to effective hiring at scale, which worsen over time. For instance, online reputations become inflated over time: the (social) cost of giving negative feedback is higher than positive feedback [135]. As a result, norms shift over time, and reputation inflation worsens, reducing reliability.

While ongoing work continues to improve existing approaches to address some of these limitations, this chapter instead presents an entirely new approach to hiring at scale. Our approach is based on a widely used technique to address the need for accurate assessments of open-ended material at massive scale: peer assessment. To date, peer assessment remains the gold standard of review, as seen in its use to assess quality in top-tier academic conferences [281], grant reviewing [63], and more recently massive online classrooms [183]. This chapter investigates: can crowd experts peer-assess each others' job materials to identify qualified candidates? Specifically, we investigate if peer assessment can generate a ranked list of all job applicants from which the employer can make final hiring decisions.

As might be apparent, the conflicts of interest that arise in a hiring setting are the central challenge in realizing this approach. Specifically, because all crowd experts applying to a task presumably would like to take the job, they have an incentive to rate other applications *strategically*, to make themselves look more attractive to the employer. This chapter describes a system, HirePeer, that overcomes these conflicts. Overcoming conflicts requires both algorithms that can aggregate judgments such that participants derive no benefit from strategic assessments (*impartial* algorithms), and a careful consideration of human-centered components of this process.

First, this chapter investigates whether automatic impartial aggregation of worker assessments of open-ended work is necessary in real-world hiring settings with conflicts of interest. Our first study creates an environment within Amazon Mechanical Turk with conflicts of interest through carefully designed incentives. It then demonstrates the need for impartial algorithms, and the necessity of communicating the presence of such impartial algorithm to participants. We find an effective introduction does not need rely on explaining a complicated randomized algorithm, but rather on the psychology of choice. In a between-subjects randomized experiment ($n = 170$), we find a *consequence explanation* results in the least amount of strategic behavior [215]. On the other hand, we find communication based on a "policing" framing to be ineffective.

Second, this chapter investigates HirePeer's real-world implications for employers. Importantly, we find peer assessment is feasible for hiring in expert crowdsourcing, with accuracies of more than 90% compared to non-conflicted expert judgments (such as those made by employers). We then examine the cost of impartial peer assessment by analyzing the accuracy of three impartial aggregation algorithms [160] and find that, in practice, impartiality comes at a small price. In a between-subjects randomized experiment ($n = 150$), we find impartial peer assessment, in a setting that utilizes the consequence explanation introduced in this chapter, results in a 8% decrease in accuracy compared to peer assessment where impartiality is not guaranteed.

Finally, we explore worker-oriented implications of peer-assessed hiring. Specifically we look at, if, and how, expert crowd workers might benefit from peer assessment and feedback. We conduct a case study to deploy HirePeer in a real-world expert crowd hiring setting, where crowd experts complete an open-ended, complex task. This case study suggests peer-assessed hiring benefits crowd experts by a) exposing them to how other applicants assembled resumés and applications, b) introducing them to new skills to develop in the future, and c) giving them targeted feedback on

their job materials.

In short, **this chapter has three contributions**. **First**, it introduces peer assessment as a new, scalable, and accurate approach to hiring in expert crowdsourcing marketplaces, instantiated in a system *HirePeer*. **Second**, through a real-world deployment of three impartial mechanisms, it quantifies the tradeoff between guaranteeing impartiality and accurate ranking. **Third**, it presents a brief exploration of how workers may benefit from peer-assessed hiring.

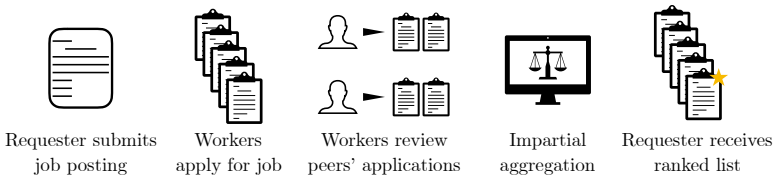

Figure 3.1. HirePeer's workflow of impartial peer-assessed hiring for expert crowdsourcing

Peer review: the gold standard of assessment

Peer review remains the gold standard for assessing open-ended materials, as evinced by its wide adoption in academia to judge paper submissions [281] and by the NSF to review grants [63]. More recently, *online* peer assessment has been introduced in educational settings; in both massive online open courses (MOOCs) and in large physical classrooms, peer assessment has proved to be an effective way to scale accurate assessments of open-ended complex work [62, 276]. However, applications of scalable online peer assessment outside of the classroom remain limited.

Realizing peer-assessed hiring requires careful consideration for how to effectively handle conflicts of interest at scale (all workers who apply to a task would like to be chosen for the task). Recently, Kahng et al. presented three impartial[2] algorithms (called Naive-bipartite, Committee, and k-partite) which aggregate pairwise comparisons to generate a ranked list [160]. While all three

[2] A ranking mechanism is *impartial* if no participant can affect her position in the final ranking [160].

impartial mechanisms have strong theoretical guarantees, we explore their performance in a real-world setting.

3.3 HirePeer: System Description

A requester using HirePeer posts her task to the labor platform (e.g., Upwork) as usual. However, instead of applying to the job directly, workers who are interested in the task are notified to apply to the task on the HirePeer website (see Figure 3.1). When applicants have completed their job application, they are then asked to review a machine-selected set of other applications. To reduce inadvertent biases in evaluation, reviewing is double-blind [183]. Before workers start reviewing, they are notified their assessments will be aggregated with an impartial mechanism.

Because prior work shows pairwise comparisons encourage attention to non-superficial features and lead to more accurate assessment [49], workers conduct pairwise comparisons of peers' anonymized job materials. An expert-generated rubric for the specific task type guides evaluation—our current system has rubrics for web design and data visualization. The rubric contains a) domain-specific criteria, b) more general criteria that are important in an expert crowdsourcing context like communication and timeliness of task completion, and c) qualitative textual feedback on job materials. An expert rubric allows us to collect accurate assessments from both novice and expert workers [44]. Feedback on application materials is later shown to both the task requester and to the applicant.

Once peer assessments have been collected, they are aggregated by the impartial mechanism. Importantly, our mechanisms aggregate assessments into a ranked list (rather than merely choosing a subset of qualified candidates). Armed with this ranked list and the qualitative feedback on each application, the requester can hire the best suited applicant on the crowdsourcing platform.

3.4 Study 1: Is an Impartial Algorithm Necessary in Peer-Assessed Hiring?

While there have been many theoretical papers on the design of impartial algorithms [71, 160], little work has been done on effectively communicating the presence of impartial algorithms to users. Such an introduction is not only important given increased calls for algorithmic transparency across the community, but also because participants may behave strategically (i.e., attempt to boost their own position) if they do not realize their assessments are aggregated impartially.

If participants behave non-strategically in general, then it may be unnecessary to communicate the impartial mechanism at all (in fact, the mechanism itself may be unnecessary except to thwart the occasional strategic behavior). But if participants engage in strategic behavior, it is important to investigate:

> **Research Question 1**: For accurate assessments, should the presence of an impartial algorithm be communicated to participants?

If strategic behavior is commonplace, then communicating an impartial mechanism may discourage it if participants believe that strategic behavior has no benefit to them. It is likely that different ways of communicating impartial mechanisms may differ in their effectiveness at discouraging strategic behavior; so our study also investigates:

> **Research Question** 2: Which framing of impartial algorithms best discourages strategic participant behavior?

Changing behavior without technical explanations

If impartial mechanisms are to be deployed widely to non-experts, it would be desirable for explanations to not rely on mathematical understanding. We consider two ways of doing so: a) by describing consequences, and b) by leveraging psychological theories of

choice to nudge behavior. In particular, we leverage the effects of different "framings," or methods to describe the same situation, that emphasize different attributes. Different framings of game-theoretic tasks result in drastically different outcomes: Tversky and Kahneman found basic tenets of rational behavior can be violated with simple word changes in task instructions [273]. These results were later corroborated in diverse, real-world applications on Amazon Mechanical Turk [228]. Thus, we investigate whether using a framing approach is even more beneficial than describing potential consequences, as it not only it does not require participants to have knowledge of algorithms or mathematics, but also it relies on fundamental and systematic human biases.

Three ways to communicate impartiality

We consider three different ways to communicate impartiality. First, we consider a *consequential* explanation. To discourage strategic behavior, we describe the consequences of using an impartial algorithm: "The ranking you generate will not affect the final aggregated ranking of your item as we use an impartial algorithm." Note that prior work suggests that such an approach may not completely prevent strategic behavior, but may reduce it. For example, Mazar et al. suggest that when consequences of "dishonest" (i.e., strategic) actions are well-known, such as while claiming exaggerated income tax exemptions, people only behave dishonestly to a small extent, as doing so allows them to preserve their positive self-image [215].

We also consider two framing-based approaches. First, we consider a *policing* approach, which is the most common technique in the related literature [45]. Participants in this condition were told, "To prevent you from cheating, we implemented an impartial algorithm." Second, we consider an *responsibility externalization* framing, based on Greenwald's theory of the totalitarian ego, specifically *beneffectance* [112]. This theory suggests while people perceive themselves to be responsible for desired outcomes (such as performing a kind act), but responsibility for undesired

outcomes is externalized to others (e.g., traffic leading to aggressive driving). As such, this theory suggests participants see themselves to be honest, but may be concerned that others may behave strategically. Participants in this setting were told, "For your protection, we prevent other workers from cheating using an impartial algorithm."

Participants and experimental setup

We conducted a between-subjects randomized experiment in early 2017 on Amazon Mechanical Turk (AMT) to test which of three communications of an impartial mechanism minimized strategic behavior compared to our control condition ($n = 170$). We used AMT as an experimental setting for two reasons: first, it can be challenging to discern strategic behavior from low quality work on AMT [149], providing a rich experimental setting to evaluate decision making; second, AMT is a representative sample of a typical online labor market, and has been shown to be a reliable environment for behavioral studies [210].

Participants were randomly assigned to one of four between-subjects conditions. The control condition made no mention of an impartial mechanism, and instead simply reminded participants to read instructions carefully (this has been shown in previous crowd work to have no effect). The other three conditions described the algorithm as above (with consequences, policing, or responsibility externalization). We displayed each in a reminder (in bold) at the bottom of the task instructions on AMT, depending on which condition a participant was randomly assigned. We also included this reminder a second time, immediately before the task.

Task structure and strategic behavior

The experiment used a simple task with known ground truth, to simplify evaluation, while still leaving room for well-defined strategic behavior.

Task We collected eight product reviews from Amazon for the bestselling mobile phone when this study was conducted: the

Samsung Galaxy. The reviews were collected to have large differences in quality (the numbers of up-votes for the reviews differed by orders of magnitude). We then introduced typos into each review. Unbeknownst to the participants, all participants edited the same review across all conditions, which was at position #6 in ground-truth (where product review #8 was lowest in quality).

Participants were first asked to proof-read these reviews, and fix typos. Each participant then ranked eight product reviews from the Amazon product page (i.e., without introduced typos), and their edited review, in terms of quality. The product reviews, including their own, were presented to participants in order of true quality, measured by the number of up-votes on Amazon. The task took at most 15 minutes, and participants were paid $10 USD per hour (before bonuses, described below).

Incentives for strategic behavior Participants were notified the rankings provided by all study participants would be aggregated (similar to peer-assessed hiring), and they would receive a bonus if their review landed in one of the top five positions in the aggregated ranking (a similar incentive structure to peer-assessed hiring). Specifically, the bonus structure was $5 USD if their review landed in position 1, $4 USD for position 2, and so on, and bonuses were awarded as promised. Because most workers in AMT's labor pool participate to earn money, this task's incentive structure aligns with participant motivations, and is therefore an ecologically valid way to create a similar incentive structure to peer-assessed hiring [149]. Each participant edited the same review, compared it to the the same ground truth ranking of reviews, and had the same incentive to manipulate their report.

This incentive structure also allows for only one kind of strategic behavior: exaggerating the ranking for the edited review, by placing it above position #6. It also allows for a measure of strategic behavior: how much higher than position #6 they placed their review (as reviews differed in quality by orders of magnitude).

Comparison to peer-assessed hiring This task design has critical similarities to hiring. First, ranking edited reviews is similar to

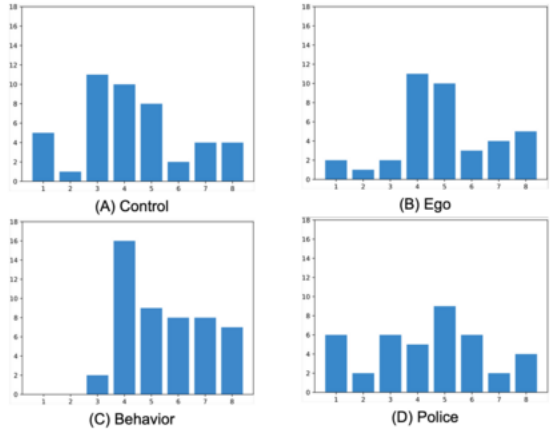

Figure 3.2. From Study 1, histogram of review placement for each framing condition; x: position, y: frequency. A skew to the right suggests less strategic behavior. Consequence explanation resulted in the least strategic behavior.

ranking job materials, e.g., resumes; and the ranking is similarly subjective, allowing for strategic interpretation. Similarly, there is a strong incentive to rank oneself higher.

The task differs from peer-assessed hiring in that participants are only comparing one artifact, instead of the multiple used in hiring, such as resumes, work experience, etc. Such a comparison would be even more subjective, but allows for similar strategic behavior. Second, our task has bonuses for even small strategic behaviors. The hiring scenario would be more analogous to having a very large bonus for position #1 (i.e., being hired), and vanishing bonuses for other positions. Our task design is necessary because we seek to measure the degree of strategic behavior.

Result: Need for introduction of impartial algorithm

Participants spent a median duration of 9.5 minutes to complete this task. In the control condition, participants had a significantly lower average rank (mean = 4.2, ground truth = 6, $F(1,166) = 15.3, p < 0.001$). In other words, control participants exaggerated their assessment by 30%, suggesting an impartial algorithm (and its effective communication) are necessary.

Result: Consequence explanation most effective

As shown in Figure 3.2, participants exposed to the consequence explanation exaggerated the ranking of their product review an average of 10% ($p < 0.01$), far less than the total possible, and lower than both the control and other framing-based explanations. This is similar to the results of Mazar et al., where participants engaged only in limited strategic behavior when consequences were known [215].

3.5 Study 2: Is Peer Assessment for Hiring Accurate?

Study 1 demonstrated the need to communicate an impartial framing, and an effective way to do so. Study 2 investigates the real-world performance of impartial ranking. Impartial rank-aggregation methods guarantee their outcomes are resilient to strategic assessments (i.e., artificially inflating a worker's own position), but in theory, impartiality comes at a cost to accuracy [160]. This is because an impartial aggregation algorithm, by design, ignores some information (for instance, Naive-bipartite disregards 75% of comparisons in expectation to ensure impartiality).

In practice, the effect on overall accuracy is context dependent. On the one hand, the final ranking may be more accurate if participants report more accurate assessments (because manipulation is no longer beneficial). However, if the strategic manipulation without such a mechanism is small enough, the loss of information

Table 3.1. From Study 1, consequence description leads to the least amount of strategic behavior. β coefficients are the average difference in rank from control condition (positive is less strategic behavior).

Coefficients	β	F	p-value
Intercept (control)	4.2667	15.336	<2e-16
Police	0.1083	0.267	0.78971
Responsibility Externalization	0.7333	1.783	0.07630
Consequence	1.2333	3.216	0.00156

during aggregation may result in lower real-world accuracy. Furthermore, if participant outcomes are not dependent on their own assessments, some participants may put in less effort in creating accurate assessments.

In this study, we investigate:

> **Research Question 3:** Does peer assessment result in more accurate ranking of applicants in an expert hiring setting?
>
> **Research Question 4:** What is the net cost in accuracy for impartial guarantees of ranked aggregation?

Participants and recruitment

We conducted a two-condition between-subjects experiment on AMT with 50 participants per condition in early 2017. Workers who had previously taken part in our studies were not allowed to participate. This study was conducted on AMT because the platform allowed us to readily hire a large number of workers, as required for our experimental design below.

Task structure

Study 1 used a simplified task structure to make strategic behavior readily apparent. This study uses our HirePeer system introduced before, and asks for multiple paired-comparisons, instead of a ranking task.

Since multiple comparisons can be composed into a (partial) ranking, the two tasks are similar in the strategic behavior they support. However, we acknowledge that participants may not see as readily how best to behave strategically while comparing two artifacts created by peers.

To simulate the hiring scenario, we wanted a "job" that most AMT workers would believe they were qualified for, and had subjective selection criteria but did not require specific domain skills. Furthermore, because AMT is a micro-task market where workers are not looking for long-term employment, we wanted tasks that

did not require workers to commit to long-term work, yet offered a significant monetary reward.

Therefore, our task asks crowd-workers to write feedback to newcomers to AMT. This is a task that is subjective, does not require specialized domain skills, and is something expert AMT workers might believe they are qualified for. To ensure participants felt they were qualified, participants were required to have a Master's Qualification on AMT: an indication of consistently high quality performance and familiarity with AMT. Along with potential bonuses, the task paid up to $20, which is a significant monetary reward on the platform.

Task design Participants were first asked to write several paragraphs of advice for AMT newcomers. The task instructions stated, "In your advice paragraphs, share tips on how to be successful, mistakes you made that you recommend they avoid, and other information you think a new Turker would find helpful."

Then, they assessed a randomly selected subset of other peers' work (i.e., their peers' advice). Concretely, at most four hours after the first phase, participants completed 50 randomly-generated pairwise comparisons among pieces of advice written by peers in the same condition, deciding which piece of advice in each comparison was higher quality; quality was defined as more actionable and specific. Repeated pairwise comparisons were permitted (and outputs were used for quality control). At the end of both phases, participants were asked to complete a 13-question survey to understand perceptions of trust, fairness, and effort. We also captured how long they spent writing advice.

Incentive structure: Participants received a bonus if their advice piece placed in the top ten spots of the overall ranking, out of 50 total spots ($10 USD for position one, $9 USD for position two, and so on). There were two conditions. The *impartial* condition used the *consequence explanation* from Study 1. The control condition did not include this explanation, and instead reminded participants to pay attention to instructions (as in Study 1).

Collecting ground truth: Ground-truth ranking for each condi-

tion's advice was generated by asking 50 non-conflicted workers—25 per condition—to compare pieces of advice. This is similar to ground-truth collection in other peer assessment evaluations [183]. Non-conflicted participants were both Master Turkers and completed over 10,000 accepted human intelligence tasks (HITs) to establish a high level of expertise in the task. Non-conflicted participants conducted 50 pairwise comparisons for which piece of advice (generated from conflicted participants) was of higher quality; quality was defined as actionable and specific. All non-conflicted participants evaluated the same 50 comparisons to generate ground-truth. Note that this method yields *ground truth comparisons*, rather than a ground-truth ranking. Ranking the 50 pieces of advice would be a prohibitively time- and effort-intensive task.

Data analysis

First, the lead author read all responses to ensure they were sensible; all but three responses across conditions were grammatically correct and included actionable advice. These responses were kept for the following analysis. The quality of advice was similar across conditions: 1,044 characters in control vs. 1,143 characters in impartial; length is correlated with quality [172]. Median time spent writing advice (9.5 minutes control vs. 6.5 minutes impartial) did not differ significantly. This suggests no differences in participant recruitment across conditions.

To create rankings, we used jackknife resampling, similar to other peer assessment evaluation work [183]. In each condition, first we chose 35 of the 50 conflicted participants without replacement and sampled 25 of their pairwise comparisons, also without replacement. Because impartial algorithms are *randomized*, we ran each impartial rank-aggregation algorithm 50 times on each set of assessments to capture the variability of results. Similarly, we repeated the process of choosing participants and assessments 25 times for each condition to capture the variability caused by choosing particular assessments. This process as a whole resulted in

1250 bootstrapped rankings across conditions. We then used bootstrap significance tests introduced by Politis and Romano [231] for accuracy measures.

To evaluate the accuracy of our ranking mechanisms, we measured the agreement between the complete ranking output by each mechanism and the non-conflicted comparisons. First, given the output of a ranking mechanism, we extracted the 50 pairwise comparisons seen by non-conflicted participants from the output of the peer assessment process. Then, we assigned the output a score that measures how well the ranking agrees with the non-conflicted comparisons. The score is equal to the total number of non-conflicted participants who agree with the relative ordering of the 50 pairwise comparisons in the output ranking divided by the total number of non-conflicted participants in the majority opinion for all 50 pairwise comparisons. Note that the score is calculated relative to the majority of non-conflicted participants; this allows us to penalize mechanisms less for confusing the order of alternatives that non-conflicted participants are less sure about (i.e., which have only a slim majority among expert opinions) and to penalize mechanisms more for disagreeing with the order of alternatives that non-conflicted participants heavily agree with (i.e., alternatives with a solid majority consensus among non-conflicted participants).

Result: Peer assessment with conflicts of interest is accurate

To generate rankings without guaranteeing impartiality, we used the Kemeny rule [167], a standard method to generate rankings from an incomplete set of comparisons. Overall, the aggregated peer assessed ranking was highly similar to non-conflicted participant judgements. Even without aggregating peer assessments in an impartial manner, the accuracy was 96.6% using our metric above; see Chapter 3.2. This suggests peer assessed hiring could form the basis for scalable expert hiring.

Result: Guaranteeing impartiality leads to a modest loss in ranking accuracy

We compared the performance of the Kemeny rule with no framing (the *control* condition) to rankings generated from data from the *impartial* framing condition with impartial aggregation. The accuracy of ranked aggregation decrease by 8% (96.6% in control/non-impartial, vs. 88.8% in impartial); see Chapter 3.2. In other words, the theoretical guarantees of impartiality come at a cost of 8% in accuracy in our experimental setup.

What is an 8% loss in practice? If non-conflicted participants generating ground-truth assessments are 75% in agreement on average, as was the case in our study, and perform 20 comparisons each, then with 20 candidates a 6.67% loss in accuracy corresponds to two switches in the true ranking (e.g., switching candidates in the 10th and 11th position with each other, and the third and fourth positions with each other), and a 10% loss is equivalent to three such switches. Depending on the stakes, this loss in accuracy (and the resulting increase in employer time to hire) may be acceptable.

Result: Consequence explanations catalyze beliefs that assessment effort is unrelated to final ranking

Participants in the impartial condition were significantly more likely to believe their effort did not impact the final ranking of their advice piece (Control median: 4, Impartial median rating:

Table 3.2. From Study 2, (Naive-bipartite) aggregation led to a reduction of accuracy by 8%, as compared to aggregation of assessments from control condition with the Kemeny rule; each entry represents average accuracy for each condition and related aggregation. All other rows represent aggregations of assessments from experimental (i.e., impartial) conditions.

Aggregation Mechanism	Average Accuracy
Kemeny	0.9665*
Naive-bipartite	0.8884
Committee	0.8044
k-partite	0.7831

2, 7-point Likert scale; Wilcoxon $Z = 612.5$, $p < 0.01$) (No other survey responses differed significantly across conditions). This is interesting because the impartial framing makes no mention of how effort affects ranking. In fact, to be effective, the impartial mechanism relies on worker assessments to be honest and effortfull. It seems likely that because of this belief, participants in the impartial condition put in less effort into comparisons, slightly decreasing accuracy.

In sum, Study 2 suggests peer assessment is an accurate alternative to hiring based on expert assessment. The benefits to employers, such as decreased time to hire, and lesser reliance on worker reputations are potentially enormous. Employers can also guard themselves against individual strategic assessment at a small cost (8%) to accuracy. Next, we turn to how peer-assessed hiring may affect workers.

3.6 Study 3: Do Workers Benefit from Peer-Assessed Hiring?

In the classroom, peer assessment improves students' self-reflection [183], iteration on work [184], and development of criteria for goodness that are better aligned with experts [49]. Do these benefits transfer to workers in peer-assessed hiring? Furthermore, what reactions do expert crowd workers have to peer-assessed hiring more generally? In short, we investigate:

> **Research Question 5**: What benefits of peer assessment in education transfer to peer-assessed hiring?

To address this research question, we conducted a case study for hiring on Upwork.com in early 2017; an expert crowdsourcing platform for programmers, designers, and other expert professions. Note this case study is meant to be suggestive, rather than evaluative. If participants reported none of the benefits of classroom peer-assessment, then this may not be an aspect to study further in future work. On the other hand, if participants reported some

Table 3.3. From Study 3, average Likert scores from post-use survey; 1: strongly disagree, 5: strongly agree. Even in a competitive hiring setting, expert crowd workers perceived peer assessment to be helpful, enjoyable, and were inclined to iterate on their job materials.

Question	Average Likert Score
I enjoyed the process	5.0
The feedback helped me	5.0
I put in effort	4.2
I was honest	4.8
My peers put in effort	3.6
My peers were honest	4.0
I will make changes to resumé	4.6
I will learn a new skill	3.6
My effort affects my ranking	4.0

benefits (as we found), these findings may better inform and focus further research. First, to inform the design of this study, we ran two small pilots: hiring for a data visualization project and a Django development task. For this present case study, we hired expert crowd workers for the task of creating a banner ad for one of our research group's software tools, and included details about this study alongside the job description. Eleven Upwork professionals applied to this task. We describe results from the five participants who completed every stage in our protocol. We acknowledge that because of the attrition rate, collected feedback may be biased.

Consenting participants submitted their anonymized applications to HirePeer (witnessing the impartial framing). Then, they conducted three randomly generated pairwise comparisons among their peers' job application materials. Since our system asks for comparisons, we modified the comparison-based user interface developed by Cambre et al., to ensure that assessment was scaffolded effectively [49]. After submitting these comparisons, each participant filled out a post-use survey similar to Study 2 to gather their feedback on HirePeer. The survey consisted of Likert questions to measure perceptions of effort and truthfulness of both themselves and their peers and free-response questions about overall experiences from the process.

Additionally, workers were rewarded for ranking their peers, and we ran impartial algorithms on their comparisons in order to select a winner who was invited to the task and paid for it separatelyhurft[;'][3].

Result: Feedback generation and reception helpful to identify new skills and improve job materials

Consistent with peer assessment literature in the classroom, multiple participants stressed the peer assessment process made them more mindful about writing a coherent and convincing application [250]. One participant stated HirePeer "helped me a lot to organize my mind and write the right things," and another wrote HirePeer "was a good exercise in application writing." Interestingly, all participants were receptive to feedback received from peers (again, selection bias may factor into this feedback). Concretely, participants reported they "liked comparing proposals,", that "receiving feedback of other freelancers is a great one", and also noted no other platforms integrate this feature. One participant reported "topics that were included on the proposal [peer's resumés]...helped me a lot." Additionally, participants were slightly more likely to want to learn a new skill after this process (3.3).

Result: Not all participants completed assessment

Five of the 11 participants completed all steps of the review process and the post-use survey. This attrition rate is similar to peer-assessment in large online courses (MOOCs) [176]. While our sample size is too small to draw statistical conclusions, participants who did complete our task "somewhat agreed" their effort did in fact impact their final placement (average Likert 4.0). We explore the emergent relationship between effort and impartiality in the discussion section, and how future work might rigorously investigate this.

[3] I thank Scout for several generous edits such as this throughout my dissertation.

3.7 Conclusion

To successfully provide peer feedback on freelancers' job materials, Hirepeer's algorithmic coordination of users resulted in workers exchanging momentary and indirect interactions with their peers as they reviewed each others' de-identified job materials. I argue that while Hirepeer addressed some uncertainties of independent work (e.g., closing a critical feedback loop on employment considerations), Hirepeer perpetuated other uncertainties of independent work (e.g., interacting with unknown actors). Such design decisions—to pursue large scale and deprioritize relationship building—are common among the many state-of-the-art peer systems for independent workers. Therefore, to gain a rich understanding of the myriad uncertainties independent workers faced, I began a longitudinal qualitative analysis of online freelancer experiences over three years (detailed in Chapter 4). Alongside, I began to build community partnerships with existing non-profits with positive reputations for supporting diversity in independent work: I joined a feminist makerspace, Prototype PGH [14], as a member in 2018, and I joined an entrepreneurial hub, Community Forge [13], as a member in 2019. Ultimately, both of these memberships developed into mutually beneficial research partnerships, which are detailed in Chapters 5 and 6.

4 A Longitudinal Study of Independent Workers

4.1 Overview

In Chapter 4, I report a longitudinal, qualitative study which involved semi-structured interviews with a set of 20 online freelancers at two time periods, three years apart (2017 and 2020) who used popular online labor platforms such as Upwork.com and Fiverr.com (software developers, writers, data entry clerks, marketing specialists, graphic designers).[1] We found that online freelancing provided unique career development opportunities over a longer period of time such as entrepreneurial training and reputation, skills transfer and career exploration and transition. However, long-term engagement with online freelancing involved a set of financial, emotional, relational, and reputational burdens that represented the unique overhead of maintaining an online freelancing career, as compared to a traditional career in knowledge work. One strategy workers developed to resourcefully address this overhead included how online freelancers' used their offline jobs (they often had multiple forms of employment) to seek social support, skill training, and wage negotiation support among colleagues which freelancers then used in online jobs.

[1] The published version of this work can be found in *Blaising, A., Kotturi, Y., Kulkarni, C., & Dabbish, L. (2021). Making it work, or not: A longitudinal study of career trajectories among online freelancers. Proceedings of the ACM on Human-Computer Interaction.*

4.2 Introduction

Careers no longer consist of a series of stable jobs within traditional organizations. Rather, they are evolving into project- or task-based engagements across multiple organizations, employers and work contexts, occasionally in short sequences or even in parallel [15, 46, 127, 165, 166, 257]. This recent fragmentation and taskification of careers is largely fueled by the rise of the gig economy and resulting "just-in-time workforce" [73] facilitated by digital labor platforms introduced over the last decade.

The global market for online labor has grown by approximately 50% over the last three years [6, 4] as millions of freelancers increasingly turn to online freelance platforms to access work. Online freelance platforms allow independent employers (clients) to connect with workers remotely, offer temporary positions and accomplish a diversity of tasks and projects. These platforms remain a growing source of remote work for a large set of skilled occupations (e.g., software engineering, digital marketing, writing and translation).

However, despite millions of workers increasingly turning to online freelance platforms [6, 4, 163], it is unknown how this unique new form of work influences online freelancers' career experiences and evolution, especially in the long term [20, 127]. Furthermore, understanding career development, evolution and sustainability in new forms of work, such as online freelancing is of growing importance given that contemporary careers as a whole are becoming increasingly less structured, linear and predictable than in decades past [46, 165].

Prior research has largely described the challenges online freelancers experience in their day-to-day online freelance platform activities, such as heightened uncertainties from algorithmically controlled reputation systems, unmet information needs and power asymmetries (e.g., [35, 152, 192, 237]). Further research has identified that some freelancers have distinct career development motivations for online freelancing, such as skill development and entrepreneurship [28, 109]. Yet we do not know the extent to

which these motivations are realized as individuals engage in online freelancing over many years, or how their career challenges, goals and strategies evolve as a result of online freelancing. We are also largely unaware of the practices they develop to participate in this form of work over a longer period of time.

Therefore, this chapter focuses on the following central research questions:

- What is the longer-term experience of online freelancing?
    - What challenges do online freelancers experience sustaining their online freelancing careers?
    - What strategies do online freelancers develop over time to manage their online freelancing careers?
    - How do online freelancing activities relate to broader career goals?

To answer these research questions, we conducted interviews with a set of online freelancers at two time periods, two and a half years apart. Using this method we contribute a unique longitudinal perspective of the experience and evolution of maintaining an online freelancing career. First, we found that long-term engagement with online freelancing can involves distinct set of financial, emotional, relational and reputational burdens that represent the overhead of maintaining an online freelancing career. Furthermore, we found that some online freelancers cope with these burdens by developing strategies in an attempt to ensure career security and sustainability. Finally, we found that online freelancing can support freelancers' career goals and development in unique ways. Specifically, we highlight three cross-cutting career development opportunities afforded by online freelancing that emerged frequently from our longitudinal data: career domain exploration and transition, entrepreneurial training, and reputation and skills transfer. Our findings raise critical questions about the potential and sustainability of online freelancing. We situate our findings within the broader discourse surrounding online freelance and gig

work and outline policy and design implications based on the results of our longitudinal study, including a multifaceted approach to mitigating the overhead of online freelancing, supporting on- and off-platform career fluidity and fostering productive online client-freelancer relations.

This chapter further contributes to the growing research on career and professional development research outside of a traditional organization or workplace settings (e.g., [80, 140, 207]) in both the Computer-Supported Cooperative Work (CSCW) and Human-Computer Interaction (HCI) communities. Career research within CSCW and HCI has examined the needs of low-resource job seekers [80, 82], how online communities can support career transition and informal professional development [207], and how people leverage online tools and their online presence to build a professional identity [95]. Our research contributes to this body of work by not only informing our understanding of careers in online freelance platforms, but also by articulating the relevance of longitudinal research within HCI and CSCW career literature. We argue that HCI and CSCW researchers and practitioners need to consider the longer-term impact of sociotechnical systems on career development and evolution. Such a perspective is essential to identifying what workers, policymakers and designers can implement to adapt to and support new career structures in a rapidly changing world of work [20, 127].

4.3 Method: Qualitative Longitudinal Study with Interviews and Surveys

Our longitudinal study draws on interviews with online freelancers conducted two and a half years apart. First, we conducted interviews with 29 online freelancers and surveys with 198 online freelancers recruited from three online freelance platforms: Fiverr, Upwork and Etsy from June to August 2017 to understand participants' motivation and journey to online freelance platforms, as well as their initial work conditions. Based on the analysis of our

initial data, we conducted 20 follow-up interviews with a subset of our original sample two and a half years later, focusing on how their work on online freelance platforms and careers as a whole had evolved. See Figure 4.1 for an overview of the research timeline.

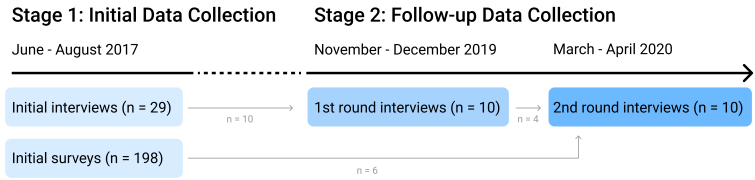

Figure 4.1. Schematic of this chapter's overall research method (numbers on arrows represent number of participants). This qualitative method follows a subset of freelancers over two years, and yields a detailed description of career evolution among online freelancers.

Motivation and Benefits of Conducting a Longitudinal Study

Longitudinal qualitative research (LQR) is distinct from other qualitative approaches as time is integrated into the research process so that change can be a key focus of analysis [268]. LQR has the unique potential to contribute to sustainable design, intervention and policy recommendations to support careers in new forms of work, as the long-term view of evolving in this relatively nascent type of work remains largely uncharted. For instance, LQR can enhance the validity in representations and explanations of an inquiry space and provides a unique opportunity to "reach areas that quantitative research cannot reach, producing high quality, in-depth data, and providing great explanatory value" by providing a more realistic understanding of causality [247]. Thus, LQR can provide a detailed and robust understanding of change over time (how and why things happen) and intervening social and contextual processes that interact and coalesce to produce individual outcomes, such as career trajectories among online freelancers [219, 268].

Longitudinal Consent and Considerations

Following recommended practices for LQR, we ensured that informed consent was "not a one-off event, but a process, with continuous consultation necessary throughout all phases of the research" [101, 247] by consulting and gaining additional consent from participants prior to their follow-up interview. Drawing inspiration from Howard and Irani's call for ethics of care and collaboration in HCI, we further attuned ourselves to how our participants might be invested in our research process and findings and how our research can and should respond to this investment [72, 137, 185]. In addition to consulting and gaining consent for our follow-up study, we sought to care for participants by expressing our gratitude for their commitment to our project, closing interviews by inviting participants to share anything they thought we should know or any questions they had for us and reiterating our availability should they have any questions or concerns or interest in our research following our interview. Finally, the first author conducted both sets of interviews and was thus able to "maintain continuity for participants" by remaining a consistent point of contact and interviewer [247].

Initial Data Collection with Online Freelancers in Summer 2017

Interviews

We began by conducting semi-structured interviews with 29 online freelancers in June and July 2017. We recruited participants from three online freelance platforms: Etsy.com (marketplace for handmade and vintage goods), Upwork.com and Fiverr.com (marketplaces for digital services such as writing and web development). While all companies are based in the United States, their platforms are used by a globally diverse population. In all, we conducted 29 semi-structured interviews in the first time period. Interviewees were online freelancers (ages 18-60; 17 female, 12 male); 15 Upwork, 8 Fiverr, 6 Etsy. We worked to recruit online freelancers with diverse levels of experience (e.g., duration of online freelancing,

education, offline work history), success (e.g., profile rating, jobs completed, hourly rate, total earnings) and demographics (e.g., ethnicity, age, gender). To recruit participants, we used a combination of targeted and snowball sampling [196]. To aid in recruitment, we created job postings and messaged participants using tools provided by the platform. Interviews were conducted in English, via video or phone call or messenger and ranged from 30 minutes to one hour. Participants were compensated $10. Interview questions focused on their motivation for online freelancing, as well as their experiences and challenges of being an online freelancer, such as skill-development activities and interaction with clients and other freelancers.

Surveys

In order to obtain baseline experience data from a larger, more representative pool of online freelancers for later follow up, we also conducted a survey with online freelancers between July and August 2017. For this survey, we recruited 204 freelancers from the same three platforms (Upwork, Fiverr, Etsy); however, we excluded from our analysis participants who spent less than five minutes on our survey, leaving us with 198 responses. We structured our survey questions to complement our interview findings, creating closed-ended questions about activities and challenges based on codes from our interview responses. In total, our survey included 18 questions: 4 free responses, 14 multiple choice (select all and only one answer). Participants were compensated $5 (<30-minute task). Similar to interview recruitment, survey recruitment used a combination of snowball sampling and targeted outreach. Interview participants were not allowed to participate.

Data Analysis of 2017 Interviews and Surveys and Design of Longitudinal Study

In the two years leading up to and during our follow-up interviews, we actively immersed ourselves in our data and related literature. In particular, we performed qualitative coding and affinity dia-

gramming of the skill and career-related portions of our 2017 interview and survey responses, developing themes to explore in more depth. From June to September 2019, all authors met to review and compare themes from our initial dataset with emergent online freelancing literature. During this review of our data and recent literature—including both unique and overlapping career and skill development themes—we noted critical, yet unanswered research questions related to these topics, as well as dominant themes within our data that would be valuable to explore longitudinally. Based on our preliminary analysis from 2017, we also decided at this stage to focus solely on online freelancers recruited from Upwork and Fiverr (rather than Etsy) because the nature of their work was fundamentally different than that of the sellers in Etsy.

Follow-up Interviews Two Years Later

Recruitment: Two rounds of interview data collection

We conducted follow-up interviews in two rounds, allowing for iterative cycles of analysis and data collection recommended in a grounded theory approach [261]. In our first round of follow-up interviews, we sampled exclusively from initial interview participants. We contacted previous interview participants via messaging systems on social media (e.g., LinkedIn) or freelance labor platform (e.g., Upwork). Outreach via non-platform outlets was essential to avoid survival bias and allowed us to reach participants who had stopped working online or using the primary platform where we originally recruited them. During this first follow-up round, we conducted 10 follow-up interviews with previous interview participants (see Table 4.1).

Our analysis of interviews from this first round raised additional questions and suggested several relevant participant variables and dimensions that might affect the representativeness of emergent themes within our data, such as the duration of online freelance work prior to our initial interview, reasons for online freelancing, as well as the domain, type and distribution of online

freelance platform work. We then conducted a second round of follow-up interviews to extend our data collection. In this second round, we drew on our survey data corpus of open and closed-ended responses from 198 online freelancers to identify and recruit previous survey participants based on the aforementioned gaps in our data. Based on this, we targeted a subset of survey participants and invited them to participate in a follow-up interview. In total, we conducted six follow-up interviews with previous survey participants (See Table 4.1). During this second round, we also conducted four additional follow-up interviews with previous interviewees who indicated interest following our first data- collection period. In all, we conducted 10 interviews in this second follow-up round (Table 4.1). This second round of data collection helped address the identified potential gaps in relevant characteristics of our first round and also incorporated negative or atypical cases, strengthening our understanding and explanation of typical cases [195, 272].

Protocol for Follow-up Interviews

We followed a general protocol for each interview, focusing on participants' career experiences and evolution (on- and off-platform), career perceptions and future goals between our interviews. We tailored our follow-up probes for individual participants based on their previous interview or survey data. Before each interview, the first author reviewed and made detailed notes of each follow-up interviewee's previous transcript, codes and memos (in the case of previous interviewees) or survey responses (in the case of previous survey participants). Between our two data-collection periods: November to December 2019 (10 interviews) and March to April 2020 (10 interviews), we analyzed our data and iterated our protocol to further explore emergent themes related to our guiding research questions. Follow-up interviews lasted between 60–90 minutes (except in the case of P5 whose interview was 40 minutes due to caregiving constraints) via Zoom or Google Hangouts and were audio-recorded. Participants were compensated $25.

Data Analysis

All audio recordings were partially transcribed with an automatic transcription service (Temi.com). We then reviewed and corrected transcriptions prior to loading interviews into the Dedoose software for analysis.

Mapping Career Trajectories and Analytical Memoing

Following our first data collection, we began by creating visual maps of the career trajectories of our first 10 follow-up interviewees. We used data from our initial interviews in 2017 to map their journey to online freelancing and their experience leading up to our initial interview, and used the follow-up interview data to highlight major changes in terms of their activities, experiences and important events over the two-year period. Coupled with open coding and analytical memoing (as discussed next), we used this primarily exploratory analysis to begin to understand the effect of specific events or circumstances on participants' career trajectories (i.e., triggers of changes to where, what and how they worked) over time. Additionally, this exploratory analysis allowed us to identify initial categories of change in participation (e.g., moving off-platform, fully or partially abandoning online freelancing), which we returned to while qualitatively coding our data. During data collection and analysis, we wrote analytical memos to cultivate constant reflexivity—critically challenging our assumptions, examining our analysis process and iteratively expanding and connecting emergent themes in our data [34]. We met weekly during and after data collection to discuss and iterate these memos.

Qualitative Coding

We began analyzing our follow-up interview transcripts using a grounded theory approach [107, 261], beginning with open-coding of interview transcripts. Three researchers independently coded a subset of interviews and met to discuss and clarify codes and emergent themes. The first author open-coded all remaining interviews. We aimed for variation in participant variables and dimensions,

Table 4.1. Follow-up interview participant demographics (n=20). Domain categories based on Online Labour Index categories of platform occupations. indicates initial data collection was via survey rather than interview [163].

ID	Age	Gender	Location	Platform in 2017	Years online freelancing prior to initial data collection	Primary online freelancing domain(s)
P1	40-50	M	US	Upwork	1-2 yrs	Software development and technology
P2	20-30	M	US	Upwork	<1 yr	Clerical and data entry; Writing
P3	30-40	F	South Africa	Upwork	<1 yr	Writing
P4	30-40	F	US	Upwork	<1 yr	Professional services; Creative and multimedia; Writing
P5	20-30	F	US	Upwork	1-2 yrs	Clerical and data entry; Writing
P6	30-40	F	US	Upwork	1-2 yrs	Writing
P7	30-40	F	Phillippines	Upwork	3-5 yrs	Clerical and data entry
P8	20-30	F	US	Upwork	1-2 yrs	Software development and technology; Sales and marketing support
P9	30-40	F	Phillippines	Upwork	<1 yr	Clerical and data entry
P10	30-40	F	US	Fiverr	3-5 yrs	Professional services; Sales and marketing support
P11	20-30	M	Jamaica	Fiverr	1-2 yrs	Professional services; Sales and marketing support
P12	20-30	F	Nigeria	Fiverr	3-5 yrs	Software development and technology; Professional services
P13	30-40	M	US	Fiverr	3-5 yrs	Creative and multimedia; Writing
P14	20-30	F	Nigeria	Fiverr	1-2 yrs	Software development and technology
P15*	60-70	F	US	Upwork	>5 yrs	Creative and multimedia; Writing
P16*	40-50	M	US	Upwork	3-5 yrs	Professional services; Writing
P17*	20-30	F	US	Upwork	<1 yr	Clerical and data entry; Writing
P18*	30-40	F	US	Upwork	3-5 yrs	Writing
P19*	20-30	F	US	Upwork	<1 yr	Clerical and data entry; Professional services
P20*	40-50	F	US	Fiverr	3-5 yrs	Sales and marketing; Writing

and continued data collection until our analysis stopped generating new codes or themes, indicating that we had approached theoretical saturation [261]. Next, we performed axial coding, grouping similar codes and analyzing them to identify higher-level cross-cutting themes around our research questions. We applied these codes to transcripts via Dedoose [2]. During this period, we frequently returned to interviews and analytical memos to clarify codes. Finally, we refined the higher-level cross-cutting themes during the paper-writing process.

4.4 Results: Maintaining Independent Workers' Careers Over the Long Term

Maintaining an Online Freelancing Career Involves Financial, Emotional, Relational and Reputational Overheads

Our longitudinal analysis of participants' trajectories revealed that the independent, precarious and platform-based nature of online freelancing placed unique financial, emotional, relational and reputational overheads on many freelancers. We found that these overheads had either persisted, compounded, or emerged

since our initial data collection and made it difficult or impossible for some participants to maintain their online freelancing career or fully realize potential career development opportunities. Our longitudinal data allowed us to analyze how this overhead broadly influenced shifts in participation, perceptions and strategies over a longer period of time. In the following section, we highlight the nature of the overhead of maintaining an online freelancing career (as summarized in Table 2) and integrate examples of their effect on changes in freelancers' participation and perceptions between data collection periods.

Table 4.2. Four types of overhead imposed by longer-term engagement with online freelancing.

Overhead	Definition	Experiences
Financial	Stress associated with income uncertainty and changing payment conditions.	Demand fluctuation Platform and client control Financial insecurity
Emotional	Stress associated with self-managed and time-limited nature of online freelance tasks.	Self-management stress Burnout from unique task demands
Relational	Stress associated with social interactions and connections required by online freelance work or lack thereof.	Limited social support and connection Online client-freelancer relations
Reputational	Stress associated with effort required build and maintain reputation to secure on- and off-platform work opportunities	Platform and client control External legitimacy

Financial overhead.

The financial overhead of maintaining an online freelancing career involved concern over the long-term financial sustainability of online freelancing, uncertainty and stress from demand fluctuation, platform and client control over income and prolonged difficulty finding work.

Demand fluctuation. The constant fluctuation in demand on online freelance platforms made it difficult or impossible for some participants to anticipate when they could find gigs on a single platform, or solely rely on online freelancing to remain financially afloat in the years following our initial interview. For a few participants who had specialized in specific skills and domains since

our initial interview, demand fluctuation frequently resulted in seasons where they struggled to find a sufficient number of gigs within their skill or domain areas to financially sustain their work. For instance, the constant demand fluctuations on Fiverr required P14 (who specialized in software development gigs) to secure additional work on a microtask platform that he disliked in order to ensure a consistent income in the time between our interviews. P13 echoed the sentiments of several participants as she articulated how *"the demand [of online freelancing] is always so random."*

For a few participants, mobility since our initial interview did little to mitigate the prominent effect of constant demand fluctuation. For instance, despite P5's upward mobility within her online freelancing career since our initial interview (e.g., expanded online freelance project portfolio and reputation), she was shocked by persistent demand fluctuation that made it challenging for her to plan or save over a longer period. Similarly, P12, a full-time online freelancer who relied solely on his income from Fiverr, discussed his continued challenge over the years with rapid gig demand fluctuation on the platform, often oscillating from a few gigs to numerous gigs coming *"in bulk"*, making it nearly impossible to estimate how much work he could secure in a given week.

Platform and client control over income. For some participants, client and platforms' largely unregulated ability to end a contract or close a freelancer's account without forewarning or explanation often induced stress and exacerbated long-term financial uncertainty in the years between our interviews (P10, P13, P14, P12, P19, P16). Participants working on-platform, as well those who worked with clients directly off-platform, faced this uncertainty. For instance, P19 described the stress induced by a recent experience where her client kept her contract active, but unexpectedly reduced her previously full-time contract with no forewarning. P19 reflected on this recent experience:

> "It seems like you're a full-time employee of the company. You're speaking to everyone there, but on paper, you're an independent contractor [...]. They need us

> later, but because we're independent contractors, they can keep the contract, but give us nothing to do at the moment." (P19)

This abrupt shift in P19's work with her client—going from full-time to essentially no online freelance work or income—highlights the power clients possess to alter payment conditions of their project-based contracts on Upwork and, as a consequence, online freelancers' financial security. Other participants discussed degrees of uncertainty around a commonly observed situation in the time between interviews: platforms *closing* freelancers' accounts, often with no warning or explanation. For a few participants, these realities solidified why *"job security is not a thing (P12)"* when working on online freelance platforms, especially in the long term.

Additionally, several participants discussed their hesitation around platforms' increased service fees and roll out of various *"pay to apply"* policies that required freelancers to pay to apply for gigs in the years between our interviews (P5, P1, P13, P12). A few participants cited these policy changes as their reason for migrating off-platform, in addition to circumventing platform control over their income. However, moving off-platform was often a double-edged sword: on the one hand, it reduced platform control and fees; on the other hand, it often contributed to additional overhead as participants recounted the additional time and money it took for them to *"rebrand"* (P5) off-platform in the time between our interviews. Rebranding off-platform primarily involved learning how to professionally migrate connections and interactions off-platform with clients while maintaining trust and reputation, developing packages and contracts and building up a client referral network without direct access to gigs or clients on platform.

Prolonged difficulty looking for work with no payoff. Time spent searching or applying for work does not equate to time spent earning for online freelancers. Prolonged periods without consistent or financially sustainable gigs thus propelled a few participants to completely abandon online freelancing between our interviews (P1, P9, P2). For instance, following a decade-long career in the

foodservice industry, P1 transitioned in early 2016 to work online with aspirations of working in the information technology (IT) field with increased flexibility. In early 2017, P1's full-time remote position reduced his hours, which spurred him to focus more on expanding his work on Upwork. In our initial interview, P1 was optimistic that his new technical skills and side projects would continue to improve his reputation and access to IT gigs on Upwork.

However, in our follow-up interview, P1's initial optimism about his future on Upwork was tempered by a perpetual *"lack of interaction"* with his proposals and inability to find consistent and relevant gigs despite several months of proactive efforts and strategies. P1 reflected on the limited number of times he was able to secure IT gigs on Upwork where he found the tasks and feedback from clients more rewarding, with increased opportunities for skill development compared to his current remote job where he reported *"stagnation"* completing more mundane and repetitive tasks. Even still, P1's prolonged inability to find gigs on Upwork, combined with his need for a consistent income, ultimately outweighed this benefit and led him to abandon online freelancing at the time of our follow-up interview. Similarly, P2 and P9's discouragement over the unpaid labor of searching and applying for online freelance gigs, coupled with their stagnant growth on Upwork, led them to abandon online freelancing altogether.

Concerns about long-term financial sustainability. Participants frequently recounted uncertainty over whether they could make online freelancing financially viable in the long term, as well as the effect this uncertainty had on their participation and previous perceptions of online freelancing. For several participants, financial precarity induced practical and emotional strain over the two-year period that solidified the importance of the tangible benefits and security of traditional employment, such as a consistent salary, 401K, health benefits and paid time off. Several participants articulated how this strain fueled their eventual decision not to solely rely on online freelancing as their full-time, or in some cases,

part-time, employment in the long term (P19, P2, P17, P5, P9, P8, P4, P18).

Additionally, a few participants who continued online freelancing full-time since our initial interview reported anticipatory anxiety over financial challenges they might face in the future. For example, despite P1's confidence in her intricate plan to ensure her online freelancing career, focused primarily on social media coaching (now primarily via non-market platforms such as LinkedIn), and personal business, remained financially sustainable after over a year of unexpected *"absolute s***"*, such as going into credit card debt several months after our initial interview, her uncertainty frequently re-emerged as she observed others abandoning their seemingly successful online freelancing careers. She recounted a time shortly before our follow-up interview when she was shocked that a fellow online freelancer was departing due to financial challenges:

> "I'm, like, I thought you [other freelancer] had a bunch of clients: 'You're leaving?' I was like, 'Is nobody doing well in these things?"' (P10)

Similarly, P13, who had been online freelancing for multiple years prior to our initial interview, articulated her growing awareness of the challenges she—alongside other online freelancers—faced as many policies failed to accommodate or support freelancers. For example, despite P13's continued success in her online freelancing career, she articulated in our follow-up interview her emergent uncertainty over whether or not she could achieve her longer-term goals, such as obtaining a home loan, due to challenges proving a consistent income as an online freelancer.

Emotional overhead.

The emotional overhead of maintaining an online freelancing career stemmed from stress and burnout some participants experienced as they dealt with the longer-term negative effects of being their own boss and the tension between unique pressures from the

nature of platform-based freelance work and resulting creativity constraints.

Self-management stress. For a few participants, the constant additional labor required to be their own boss (e.g., independently defining and managing parallel projects on platform) induced long-term self-management stress, and in some cases, shifted their perceptions of the previous allure of online freelancing long term. For instance, P5 discussed the long-term stress of having to constantly manage her interactions and brand, while prioritizing fragmented tasks and client relations. This reality drove P5 from being passionate about an online freelancing career where she could be her own boss in our initial interview, to eagerly anticipating transitioning to a full-time traditional job in our follow-up interview:

> "I look forward to times where I show up to work and you [future employer] just tell me what I gotta do. [...] I like that, where I don't have to delegate my day. 9 am there is a meeting, 10 o'clock I'm meeting with, I like that. Where it's not like I have to figure everything out myself. It's exhausting every day." (P5)

Burnout from the unique demands of online freelance projects. We found that several participants experienced periods of heightened burnout after a longer period of online freelancing. Thus, regardless of participants' experience prior to our initial interview, the presence and effect of burnout emerged primarily within the temporal window between our interviews. Specifically, we found that the presence of burnout was increasingly prevalent among online freelancers, with a diversity of effects. For instance, P11 shared her personal experience with the burnout that she frequently observed other online freelancers discuss online, and the influence this burnout had on her decision to shift focus toward her offline job since our initial interview:

> "This whole onset that people [other online freelancers] are talking about online, like crazy burnout, I was hav-

ing that. It was just not healthy, so that's when I made the decision to focus more offline." (P11)

For some, burnout since our initial interview was a function of the "always-on" nature of working both on-platform and offline jobs with blurred boundaries (P11, P5), stress from working across multiple client time zones (P7), discouragement from periods of constant negative feedback and rejection (P13), or even the time-limited nature of online freelance tasks that make it challenging be in the *"right frame of mind"* to think creatively (P3). For some participants, these factors compounded each other. For example, P3 articulated how the time pressure of her tasks frequently led to emotional fatigue that was further compounded by payment uncertainty: *"There's tiredness and there's the outcome tied to it [payment uncertainty] and so it makes it doubly difficult."*

Relational overhead.

The relational overhead of maintaining an online freelancing career stemmed from the longer-term effects of limited social support and connection as an online freelancer, and the additional labor and stress induced by difficult online freelance platform clients.

Limited social support and connection. Online freelancers often work alone and do not have access to dedicated mentors or colleagues more readily available in traditional organizations. For a few participants, the longer-term burden of this absence—such as the weight of failing without a team or mentor and negative career and psychosocial effects of working independently—shifted their participation over the two-year period (P6, P8, P17, P5). For instance, in our initial interview, P6 worked as a full-time remote customer service representative and part-time writer on Upwork where she was interested in *"getting into the tech field (2017)"* with the goal of using her blog-writing gigs on Upwork to *"get into some coding (2017)"* by learning and implementing HTML and CSS. At the time of our follow-up interview, P6 had transitioned to working at a local offline organization as a junior software engineer after a little over a year of taking online coding classes. However, P6's

decision to pursue an offline software engineering job, rather than on Upwork, resulted from trepidation of failing without a team to support her during the early stages of her transition into a new career domain:

> "I look at them [software jobs on Upwork] every other day or so just to see anything that I might feel confident doing. But I always end up talking myself down. I'm talking myself out of it. I know it's too scary. So I'm really hoping to get there soon. But again, I just have this support system of my team right now [at her current position as a junior software engineer at an offline organization] and it's kind of scary to go outside of that just yet." (P6)

While the financial uncertainty of online freelancing motivated many participants to shift towards relying on traditional (offline) full-time work, the limited social connection in their online freelancing career further solidified this decision for a couple of participants. For instance, P8 expressed her frustration with being a *"voice on the screen all the time"* at her previous online freelance job with an email marketing organization where everyone else was collocated. P8 reflected on her early notions of online freelancing at the time of our initial interview—when working solo at coffee shops seemed *"cute."* Yet over time, she realized the longer-term cost of missing the *"the social element"* of a traditional workplace, such as peer recognition, networking and socialization. Similarly, P17, who began freelancing on Upwork a few months prior to our initial interview after being laid off from her full-time offline job, found that online freelancing full-time without an additional offline job negatively impacted her mental health and productivity.

Notably, remnants of the effects of limited social support and connection among other online freelancers emerged for one participant later in her online freelancing career. P20, a full-time top-rated digital marketing freelancer on Fiverr, described how prior to finding a community of sellers on Fiverr during the year prior to our follow-up interview, she felt increasingly disconnected

after years of being surrounded by people who failed to understand the legitimacy and unique challenges of online freelancing. However, while P20 was able to temper her isolation by collaborating with the sellers she managed through her new role as a Fiverr studio lead, many online freelancers around her were unable to find a similar community:

> "But me coming in [to online freelance platforms] seven years ago and talking to other people who came around that time or within a five-ish [year] frame thereafter, they still kind of feel disconnected. I mean, even this week, I was talking to somebody who'd been here [Fiverr] for five years and she was like, 'Oh, you're like the first person I've really talked to.' And I'm like, 'Really?"' (P20)

Difficult online client relations. Managing client relations remained a constant source of frustration and uncertainty for many participants even as their online freelancing careers progressed. For example, client ghosting, whereby clients would unilaterally cease communicating (P16, P1, P8), steal long-term freelancers' work (P13, P5), unclear expectations and rude communication (P16, P10, P19, P20, P13, P8, P7, P12). For a few participants, the persistent need to field difficult online client interactions and relations, despite continued progress in their online freelancing career since our initial interview, came as a shock. For example, despite P20's long-term success and reputation on Fiverr, the effect of difficult clients persisted. She described how the digitally mediated nature of interactions between clients and freelancers can lead to abusive language:

> "But more so now I think people [clients] hide and they'll just say some of just the most cruelest *(sic)* things. They don't even think I deserve to be where I am." (P20)

Others highlighted their experience with clients consistently disrespecting their boundaries over the years; for example, clients

texting them in the middle of the night (P5), or expecting them to be available around the clock (P8, P16, P9, P5). Combined, these examples demonstrate the immense relational burden that client relations frequently impose on online freelancers as many attempt to field these interactions, or are forced to adapt due to underlying power and information asymmetries, where clients often control their income and reputation for a project.

Reputational overhead.

Online freelancers in our study had to perform extra work to offset power platforms and client hold over their online reputation, to translate and gain legitimacy for online freelance work in traditional offline settings and to manage conflicting offline and online career aspirations.

Platform and client control over reputation. As several participants migrated or expanded off-platform since our initial interview, we found that reputational concerns often evolved as their network reliance increased. For instance, P13 discussed the additional lengths to which she went to avoid tarnishing her reputation among her off-platform client network. Similarly, P5 and P10's experience and fear of a theoretical domino effect among their off-platform client networks if they were unable to live up one of their clients' expectations brought a new form of reputational anxiety. For example, in our initial interview, P10 discussed her anxiety over the *"leverage" (2017)* her Fiverr clients had to damage her reputation through a single bad review, and thus her likelihood of success on Fiverr. However, as P10 expanded off-platform shortly after our interview, her anxiety shifted from client reviews and ratings on Fiverr to fear of letting one of her clients down due to the interconnected nature of her off-platform client network. For instance, P10 shared: *"My [online] reputation is everything. If I screw something up, there's a risk there, because more people will know about it immediately than [they] would if I was a random person on the job."*

As P10 further articulated, the interconnected nature of many participants' online client networks, coupled with the rapidly in-

creasing currency of reputation in a sea of competition since our initial interview, placed a growing burden on many participants to be hyper-cognizant and calculated in their work and client interactions over a longer period of time. While the reputational weight among client networks was critical for many participants who ventured off-platform between our interviews, other participants who continued to work primarily on platform discussed ongoing uncertainty over the possibility of having their reputation jeopardized by a single bad gig or negative review, as well as the additional labor often required to avoid the reputational repercussions of canceling a job on platform. Thus, across on- and off-platform freelance engagement, our longitudinal data highlights the longer-term weight of reputation maintenance as an online freelancer.

Barriers to translating and gaining legitimacy for online freelancing experience. Reputational overhead expanded off-platform for a few participants who struggled to gain legitimacy for their online freelance work from traditional employers between our interviews (P2, P11, P5). For example, P11 discussed her desire for *"local experience"* after facing unexpected obstacles translating and gaining external legitimacy from offline employers; P11 recalled being asked if she was *"committing fraud"* or *"lying"* about her online freelance platform experience in interviews with local organizations. Similarly, P5 discussed her experience as a double-edged sword when applying to offline organizations; while some potential employers lauded her initiative, most made it clear that they viewed her as *"too independent"* and *"not trainable."*

In total, four participants stopped online freelancing altogether since our initial interview. However, as highlighted in the previous section, several participants significantly reduced their reliance upon and participation in online freelancing due to the overheads of maintaining their online freelancing career over a longer period of time. In the following section, we focus on the most frequent strategies participants employed in an attempt to mitigate different facets of overhead and establish more security and sustainability in their careers.

Overhead Management Strategies

Our longitudinal analysis revealed not only the overhead of maintaining an online freelance career, but also the cross-cutting strategies participants who still pursued online freelancing in any capacity leveraged to manage distinct and overlapping facets of this overhead. These strategies included a variety of practices to diversify their work sources and contexts, modulate their repertoire of online freelance skill domains, delegate or 're-outsource' their work and increase client- and gig-vetting practices.

Diversifying and expanding work sources.
To manage the financial, reputational and relational overhead of their online freelancing career, some participants worked across multiple platforms, leveraged their off-platform work and network and appropriated platform algorithms.

Multi-platforming. Some online freelancers in our study engaged in 'multi-platforming' by finding gigs and clients on multiple platforms in order to cope with the challenges and unpredictability of working on a single platform (P13, P10, P16, P14, P17, P4, P18, P3). Working across multiple platforms allowed some freelancers to mitigate the effect of demand fluctuation, potential reputational damage on a single platform or even account closure. However, the degree to which participants leveraged multi-platforming to mitigate overhead varied in terms of the nature of engagement and motivation (e.g., consistently multi-platforming versus ad hoc multi-platforming) between our interviews. For instance, P13, whose multi-platforming strategy was more passive, transitioned to primarily connecting with freelance clients off-platform between our interviews. Thus, P13 only returned to Fiverr when a prospective client reached out to her, or as a future backup strategy to mitigate low demand off-platform: *"I still use Fiverr on occasion, but it's only if someone reaches out to me. I don't do much prospecting on Fiverr anymore."* By contrast, a few participants needed to consistently multi-platform to financially sustain themselves and manage the persistent demand fluctuation that occurred

between our interviews that contributed to financial overhead.

Expanding offline. Several participants who continued online freelancing in some capacity decided to pursue part-time or full-time offline work, or increased their reliance on offline networking opportunities between our data-collection periods. Offline expansion frequently mitigated income uncertainty and lack of social support, reducing the financial and relational overhead of online freelancing. For instance, at the time of our follow-up interview, P19 transitioned from working as a full-time online freelancer to working a full-time offline job and freelancing part-time on Upwork. During our follow-up interview, P19 articulated her increased satisfaction with her online freelance work once she did not have to deal with the heightened income uncertainty or isolation as she had in 2017.

A few participants (P8, P13, P12) further combated the demand and income uncertainty of online freelancing between our interviews by increasing their reliance on referrals from their offline network. For instance, P12 discussed securing on-platform jobs from his friends who ran local small businesses and sought out his business proposal gigs on Fiverr. For P13, sharing her freelance journey at local offline events at a local co-working space opened doors to expand her network of online freelance clients while enjoying community support that was often challenging to find as an online freelancer:

> "I've been meeting people at those events because people hear my story about how I got into freelance and then people want to know more about, 'Well, how do I get into freelance and what's the first step that I should take?' And having those open and honest conversations and being able to share my experiences with other people has unlocked so many doors for me [and] networking." (P13)

P13 thus leveraged networking opportunities from her offline community to grow her portfolio of online freelance clients. Her strategy represents a fluidity between offline and online freelance

work and opportunities that emerged frequently in our longitudinal data.

Appropriating platform algorithms. For several participants, continued experimentation and iteration with platform algorithms was essential to garnering additional clientele and combating fluctuation in demand over a longer period of time. While two participants (P18, P17) reported continuing to experiment with different strategies in an ad-hoc attempt to understand and manipulate platform algorithms to maintain or increase visibility over the years, several participants' strategies evolved to require more deliberate research and iteration. Participants often employed meticulously researched 'hacks' (i.e., ways of effectively appropriating or leveraging platform algorithms for individual benefit) to improve visibility to potential and existing online freelance clients and ensure more consistent work. Visibility-hacking generally occurred on-platform (P18, P17, P20, P3, P15). For example, between our interviews P3 identified patterns in Upwork's referral system and strategically accepted gateway gigs that triggered Upwork's algorithm to recommend her to clients, which in turn facilitated a rapid transition across domains.

Two participants discussed expanding visibility hacks to non-market freelance contexts, such as LinkedIn, as they migrated off-platform (P10, P13). For example, P10 shifted her focus from experiments with Fiverr's gig-ranking algorithm to LinkedIn between our interviews. As she migrated off-platform, she continued to adopt an intricate cycle of study and experimentation with LinkedIn's algorithm—sometimes for months on end—before making a post that garnered tens of thousands of views and significantly increased her online-freelance clientele visibility. Thus, across on- and off-platform freelance engagement, our longitudinal data highlights the increasing relevance of platform-algorithmic experimentation and adaptation as participants progressed and sustained their online freelancing careers.

Modulating online freelance skill domain repertoire.
Participants often carefully monitored trends in supply, demand, and feedback within the online freelance market environment to guide modulation of their online freelance skill domains between our data-collection periods. This strategy most frequently helped mitigate demand fluctuations, financial insecurity and reputational repercussions induced by being unable to adapt to ongoing client requests.

Abandoning competitive online freelance skill domains. For several participants, careful monitoring of platform freelance market saturation and competition since our initial interview propelled them to abandon or recalibrate the domain(s) of the online freelance work they offered. For example, P5, who focused on social media management work in 2017, noticed both an influx in the sheer volume of online freelancers offering social media management Upwork, as well as a surge in online freelancers with specialized degrees and formal training that she did not have: *"Now all of a sudden everyone's a social media manager."* P5's observation of market saturation thus led her to abandon this domain of work between our interviews and redirect her attention to skill domains where she could more consistently secure online freelance gigs.

A few participants even abandoned domain(s) of online freelance work between our interviews after determining low personal competitiveness based on client feedback and internal platform ranking. For example, P3 jettisoned her previous aspiration to transition into website copywriting in our initial interview based on one of her clients' dissatisfaction with the results of her project deliverable. Despite P3's client's acknowledgement that her dissatisfaction with P3's deliverable could have been a result of her own poor project instructions, P3 nevertheless decided to drop this domain of work based on her perceived lack of competitiveness securing consistent gigs going forward. Similarly, P14 determined he was not *"good"* at writing- or proofreading-related gigs based on client feedback and how well those gigs performed on Fiverr between our interviews:

> "I wrote something the client returned it to me, complaining that it's not good, it's below what he expected. So writing never came good to me [on Fiverr]. What else? Proofreading, anything that involves that gig. That gig was not good for me, so I stopped doing those things [on Fiverr]." (P14)

By contrast, participants often expanded the types of online freelance skill domains they offered between our interviews based on market demand and client relationship maintenance.

Adapting to changes in online freelance market demand. To mitigate demand fluctuation contributing to financial overhead, some participants discussed frequently monitoring and temporarily expanding the type of freelance work they offered during periods of low demand or periods of success finding work in their primary domain (P16, P19, P10, P14, P4). Still, others expanded their skill domains in order to access more in-demand clients and gigs (P12, P3, P20, P5, P15). For instance, during our follow-up interview, P3 discussed noticing a trend in demand for software-focused writing gigs on Upwork shortly before our follow-up interview, which led her to pursue learning about and writing on software topics:

> "I started seeing a trend. Many people [clients on Upwork] want writers who are clued [into] this recent big data topic, machine learning, how to use cloud technology. And you can see that they are very serious clients, they want people who understand the content. So I told myself, 'Hmm this is a path to pursue." (P3)

For P3, identifying and acquiring in-demand skills via off-platform courses and resources to access more consistent work in new skill domains emerged as an increasingly relevant practice since our initial interviews where she discussed her early attempts at learning what *"skills are in demand from the job postings [on Upwork]" (2017)*.

While several participants similarly looked to gig postings to monitor in-demand skill domains that could provide more finan-

cial stability in the time between our interviews, others looked to client requests to forecast what skills they should acquire and what work they should offer in the future (P20, P12, P10). Some participants even identified new and potentially fruitful online freelance domains to pursue via their more immediate networks (e.g., friends and off-platform network) (P13, P10, P14). For instance, in 2017, P13 shared her recent pivot from public relations and entertainment journalism to search engine optimization (SEO) content writing on Fiverr after she realized that the demand for online journalism gigs was decreasing: *"I knew that my days were really limited within the online journalism" (2017)*. However, during our follow-up interview, P13 shared her unexpected pivot *back* to online journalism and public relations freelance work after being continuously approached by prospective clients with requests and referrals between interviews. Combined, these examples illustrate the critical role participants' skill domain adaptability played as their online freelancing careers progressed over the two year period.

Maintaining client relationships. Several participants discussed adapting the type of work they offered since our initial interview in order to maintain client relationships (P5, P3, P19, P12). For some participants, it was a *"slow escalation"* (P5) of client requests that eventually landed them in uncharted territory and thus required them to learn new skills and technologies to adapt to client requests. While some participants described their evolution into new skill domains of freelance work based on client requests as an opportunity to learn new skills (P12, P3), adapting to client requests always required rapid unpaid learning. For example, in 2017, P12 focused on consulting and software development work on Fiverr, which included quantitative analysis. However, in our follow-up interview, P12 reported transitioning into qualitative data analysis after his current client requested additional help with the qualitative aspects of their analysis.

Yet despite the significant additional labor necessary to learn new methods and software based on his existing client's request for

additional qualitative data analysis, P12 appreciated the process as it allowed him to identify a new in-demand skill domain while maintaining his reputation with his client and thus access to more consistent gigs. For others, however, such as P5 and P19, adapting to client requests was merely a means to an end, as they were largely uninterested in the new skills or domains of work that they had expanded into in order to maintain client ties, their reputation and access to additional work.

Re-outsourcing online freelance tasks.

Several participants described different forms of *re-outsourcing* where they recruited or hired friends, family, or most frequently, other online freelancers to help complete certain tasks or portions of tasks.

Re-outsourcing to keep up. For some participants, re-outsourcing enabled them to keep up with unpredictable demands and client relationships to minimize or prevent future financial, reputational and relational overhead. Specifically, when participants were unable to complete a task (either lacking knowledge or ability) or had difficulty with specific, yet necessary tasks, they described re-outsourcing tasks or portions of tasks to friends, family or other online freelancers (P10, P5, P18, P15). For instance, P10, shared her experience re-outsourcing aspects of her projects on Fiverr that were difficult to complete, but necessary to maintain her reputation and flow of consistent freelance work: *"I have this [task] that I would not have had the capacity to do because it would've hurt my brain because that's something that's hard for me."*

Re-outsourcing to scale up. By contrast, other participants re-outsourced to manage high levels of demand and expand their reach to new clientele markets while maintaining their reputation. This scaling allowed them to ensure a consistent income stream and maintain or bolster their reputation by combining the skill sets of an organized network recruited via online platforms to tap into a new market of online freelance work (P20, P15, P18). For instance, P15, a top-rated writer with over seven years of experi-

ence on Upwork, leveraged her expert gig *"skimming"* skills—skills that she noticed many people attempting to transition to online freelancing do not have and struggled to identify. Thus, in combination with her network's diverse skill set, P15 tapped into new topics and markets on Upwork that she would not have felt comfortable entering, while simultaneously helping friends or family earn needed money and exposure to online freelancing through the tasks she re-outsourced to them.

Client and gig information-seeking.

A majority of participants emphasized the growing frequency and weight of client and gig vetting as their online freelancing career progressed. Participants' increased fluency and evolving repertoire of information-seeking tactics informed new selectivity practices aimed to prevent multiple facets of client-induced overhead.

Scanning relational signals. Online freelancers in our study reported their increased reliance on prior reviews, gig posting(s) and pre-contract communication to quickly identify client *relational signals* (e.g., client motivation, willingness to collaborate, communication tone and latency, etc.) to filter and select the right clients (P20, P3, P7, P20, P17, P19, P16, P12, P5, P18, P10, P5). Obtaining reliable relational signals allowed some participants to minimize or prevent multiple facets of client-induced overhead. For instance, to get a sense of how a future client might treat her or what their future relationship might look like, P17 searched other freelancers' platform reviews of clients for clues about what she could expect from a prospective client:

> "But the main thing I look for in the reviews is that sometimes they're all really generic like: 'that was good', or 'I liked that', or they don't tell me anything. But the [other] reviews are like, 'Hey, I really liked working with [client name], she was a good communicator, the project was really interesting.' That [is] telling me this was more of an in-depth relationship

between these two people and it seemed to work out well." (P17)

Testing clients for fit. Other participants implemented test projects to access otherwise unavailable insight about clients before fully committing. For example, if P13 (who primarily worked with clients off-platform) had concerns about potential challenges with a prospective client (e.g., unrealistic client expectations that could exact burnout or reputational repercussions), she proposed a *"test project"* that involved completing a small portion of a potential client's larger task or project to determine if there was a fit between their communication style and ideas.

Similarly, P12 proposed *"feasibility projects"* to determine if a potential client's data analysis requests were realistic given the nature of the data and task constraints. By learning how to better filter out difficult clients apriori, freelancers were able to avoid some of the relationship-management overhead more challenging platform clients often imposed.

Customizing gig and client relationship duration. Over time, we found that participants often purposefully customized the duration of their gigs and client relationships (i.e., long- versus short-term) based on their experience with different facets of overhead between our interviews. For example, while P11 mentioned the value of long-term clients in 2017 as this allowed her to see the progress of her work, her perspective shifted after she experienced burnout trying to balance her new full-time offline and online freelance work since our initial interview. Specifically, P11's long-term clients' expectations to consistently go *"above and beyond"* in her work quality exacted burnout.

Thus, to minimize the emotional overhead of her online freelance work, she shifted to working solely with short-term clients on Fiverr. For P11, short-term clients made her work more sustainable as they allowed her to balance her offline job and avoid compounding client expectations by way of mutual agreement of long-term clients' task-relative priority.

By contrast, other participants discussed the importance of long-term clients to reduce financial uncertainty and the stress of proactively seeking new gigs (P19, P16, P18, P17, P10, P14). For others, long-term clients and gigs allowed them to develop more personal client relationships and thus reduce the lack of connection that contributed to relational overhead. For example, P18 discussed her preference for long-term clients that afford more time to build trust, rapport and camaraderie with her client and even other freelancers on a project, while also feeling like a part of her clients' "*team*" of Upwork online freelancers—P18 expanded on her rationale:

> "I think there's a difference with people [other online freelancers] who are just doing work they might only take two weeks to do or a month to do compared to 'Hey, I feel like I'm really part of this team." (P18)

For some participants, successful client matching was the sole reason they were able to sustain their offline and online freelancing careers in parallel without experiencing burnout. For instance, P17, who had spent the week before our follow-up interview working overtime at her offline job recounted her relief knowing that her Upwork client would be empathetic and flexible when she asked for an extension: *"When I was coming home, I was done. My brain was tapped out and I sent her [Upwork client] the message and she was like, 'Oh yeah, I get it."'*

Career Development Opportunities of Online Freelancing

Despite the overhead and diverse array of strategies participants employed to cope, we found three cross-cutting career opportunities that emerged frequently from our longitudinal data: career domain exploration and transition, entrepreneurial training and reputation and skills transfer.

Table 4.3. Three unique cross-cutting career development opportunities afforded by online freelance platforms that frequently emerged in our longitudinal data: career domain exploration and transition, entrepreneurial training and reputation and skill transfer.

Career Opportunities	Definition	Opportunities
Career domain exploration and transition	Leveraging online freelance platforms to identify, explore and experiment with new online and offline career domains	Exploring online career domains Exploring online career domains
Entrepreneurial training	Leveraging online platforms identify market gaps and develop skills relevant to entrepreneurial aspirations via platform opportunities	Gaining market insight and exposure Developing skills relevant to entrepreneurial aspirations
Reputation and skills transfer	Leveraging and/or transferring reputation and skills from online freelance work to accelerate career	Transferring skills and reputation Acquiring within platform mobility

Career domain exploration and transition

Our longitudinal data highlights the prevalence and degree to which online freelancers leverage the access and visibility of different career domains on online freelance platforms to either intentionally or fortuitously explore and transition into new domains and career paths. Notably, freelancers' exploration occurred with no explicit support from platforms. For example, several participants used online freelance platforms to explore new *online* career domains before and between data-collection periods (P7, P20, P6, P11, P15, P3, P10, P19, P13, P4, P14).

For instance, in our initial interview, P10 shared how Fiverr had served as a unique *"testing ground (2017)"* to quickly explore and identify where her skills, interest and market demand aligned. In the time since our initial interview, P10 leveraged insights from her intricate experimentation on Fiverr and offline interactions at a networking event to successfully explore and transition into a new career: social media coaching. While P10's exploration was more linear, several participants used online freelance platforms for parallel or adjacent career exploration by exploring new domains outside of their primary domain with career development goals, even when they did not anticipate an entirely new focus within their on- or off-platform career. For example, P3, who began online freelancing to stay home with her children after receiving her PhD

in Chemical Engineering, leveraged Upwork to experiment and ultimately transition into content writing; at the time of our follow-up interview, she was continuing to pursue this career domain on Upwork even after she had transitioned back to her offline engineering career.

Similarly, P15, a children's literature author and freelancer on Upwork, had no intention of changing her primary career domain, but enjoyed challenging herself to test new creative domains slightly outside of her primary skill domain on Upwork; for example, advertisement and card writing. For others, online freelancing served as an outlet to test offline career paths between our interviews (P8, P11, P17). For instance, online freelancing allowed P8 to test web design before committing to a full-time offline web design job:

> "And then, over all that time [doing web design online freelance platform work], I've come to the conclusion that's not something that I really want to do full-time." (P8)

P17 similarly experimented with *"coding and computer software (2017)"* when she first started working on Upwork after being laid off from her offline job, yet ultimately decided she was uninterested in pursuing this career path full-time offline. Furthermore, frequency and duration of exploration varied across participants. For example, exploration via online freelance platforms occurred before and after our initial interview for a few participants. For instance, following our initial interview, P11 explored social media management gigs on Fiverr as a potential career path; and in the time between interviews, she explored and tested tutoring and consulting gigs while deciding whether or not to pursue a master's degree and teaching.

For a few participants, career exploration was facilitated through happenstance exposure to new career domains through their work with on-platform clients. For example, between our interviews, P7 transitioned from online freelancing to direct publishing after being introduced to Kindle Direct Publishing (KDP) while working

as a virtual assistant for her Upwork client who sold KDP books. Echoing the practice of several other participants, P7 leveraged online courses and tutorials to narrowly target and acquire skills she identified as relevant via on-platform exploration.

Entrepreneurial training

Online freelance platforms allowed several participants to identify market gaps through on-platform client interactions and exposure. In combination with developing both domain-specific and business skills relevant to their entrepreneurial aspirations, online freelance platforms thus served as a unique form of entrepreneurial training for several participants. For instance, in our initial interview, P13 shared how the market exposure she gained on Fiverr allowed her to connect with diverse companies and identify *"a need for women of color to actually step in and do freelance work for these companies (2017)."* At that time, P13 launched a platform aimed to connect freelancers with companies looking *"for the diverse talent they so desperately need (2017)."* During our follow-up interview, P13 shared that her staffing business was *"really taking off"* was on track to becoming profitable enough for her to *"focus on providing opportunities for other freelancers [through her staffing agency]."*

For a few participants, the client relationships they developed as freelancers on-platform even evolved between our interviews to entrepreneurial business partners (P4, P15, P13). For instance, P4, who worked on social media management projects with an Upwork client in our initial interview, reported in our follow-up interview her transition to helping her previous client hire freelancers on Upwork, with plans to start a new business venture that leveraged their unique backgrounds in social media influencing and counseling in the coming year.

For other participants, entrepreneurial aspirations remained unrealized. Yet some participants shared their plans to employ the skills they had developed through online freelance platforms for future entrepreneurial endeavors (P3, P12, P5, P14, P18). For instance, P3 shared how online freelancing provided her an other-

wise unavailable outlet to hone market insight and writing skills outside of her primary offline career, which she planned to leverage to build her own business later on in her career. Similarly, the unique consulting skills P12 acquired from working with non-expert clients on Fiverr supported his future plans to start his own local consulting firm.

Reputation and skills transfer

For many participants, online freelancing enabled them to leverage, and in some cases, transfer the reputation and skills they acquired from their on-platform freelance work to accelerate their online or offline careers.

For some, it was increased reputation garnered from their online freelancing career since the time of our initial data collection that bolstered their confidence and allowed them to acquire in-platform mobility (e.g., increased hourly rates, access to more clients and platform perks) from compounding platform reviews and referrals (P10, P3, P15, P12, P20). For example, the online marketplace context offered fewer cues (and thus, the potential for less bias and discrimination), which recently enabled P20 to gain recognition and mobility in her online freelancing career on Fiverr. She felt it was difficult, or nearly impossible, to obtain this previously in her offline job:

> "It [online freelancing on Fiverr] afforded me a different role that I don't think, even when I was in traditional [offline] roles, it was really hard to climb up because it's more afforded to men at the time." (P20)

For other participants, the reputation and skills they developed from online freelancing allowed them to build their resume and portfolio for offline jobs during periods of unemployment (P19) and even early on in their career (P11, P2, P5). Our longitudinal perspective allowed us to identify the unique ways that participants leveraged the skills and reputation they developed on-platform in off-platform career contexts.

For instance, several participants described the synergistic interactions between the skills and reputations they developed across different work contexts or mediums (e.g., offline-online, off- on-platform). For instance, P5, P2, P17, P4 and P11 shared how they transferred the skills they had developed online freelancing (e.g., domain-specific skills, communication and professionalism with clients who lacked domain expertise) to accelerate their offline career in the time between our interviews. For instance, in 2017, P17 worked full-time on Upwork and Chegg with the goal of *"using and expanding (2017)"* her skills after being laid off from her full-time offline job. At the time of our follow-up interview, P17 continued online freelancing on the side after finding a full-time job at a museum. Her motivation stemmed in part from the opportunity this combination afforded her to develop her writing and public relations skills across different environments and projects:

> "I'm doing that [translating complex information for general audiences] in both places, and then I feel like the more I'm doing that, the better I am at that [skill] in general. So they sort of feed off of each other in that respect." (P17)

While several other participants discussed similar examples of off- and on-platform work interacting to support career development over a longer period of time, it was the insider knowledge P4 gained through her experience freelancing on Upwork that allowed her to effectively hire and manage freelancers in her new full-time position. For example, P4 leveraged her understanding and empathy for the fragmented nature of online freelancing and how this impacts freelancers' schedules and availability to identify relevant hiring signals and management practices on Upwork.

4.5 Discussion and Design Implications: Mitigating the Overhead of Independent Work

In this discussion, we situate our findings within related work and propose implications for future research, design and policy. Rather

than present specific implications based directly on each of our findings, we instead suggest a set of implications that encapsulate our findings holistically. Even as we outline implications for design and research, we acknowledge that our research also suggests that effective change will require a multifaceted approach, including platform redesign, development of career support tools and resources, as well as new laws, regulation and freelancer organizing efforts (e.g., [105, 109, 156]). For instance, our findings contribute to and support an ongoing call to create a more egalitarian online marketplace, where freelancers have more power and access to benefits [109].

Mitigating the Overhead of Online Freelancing

First, our findings on the unique aspects of the overhead associated with maintaining a career online unify and extend a large body of literature on the characteristic precarity and uncertainty of gig work. Specifically, while previous work illustrates the heightened uncertainty of online freelancing (e.g., [192, 36]), our longitudinal perspective articulates the overhead this uncertainty and precarity incites, and the influence that overhead has on participation in online freelancing, in varying degrees, and over time. In doing so, our findings can inform future policy and design of technology to increase both the accessibility and sustainability of online freelancing.

With respect to platform redesign and tool development, one principle for how platform and systems designers could develop policies and tools would be to amplify existing strategies some online freelancers employed or created to help establish sustainability and security in their online freelancing career. Designing tools based on this general principle may reduce the current onus and additional labor required to identify and piece together strategies, and increase the accessibility of such strategies to those less likely to exhibit or develop necessary adaptive career behaviors in new forms of work [127]. For instance, drawing inspiration from existing 're-outsourcing' practices (i.e., contracting out certain tasks

or portions of tasks to friends, family or other online freelancers to extend capabilities or manage high levels of demand) to support new forms of distributed collaboration and learning among online freelancers. Similarly, drawing inspiration from freelancers expanding their work portfolio to maintain client relationships, platforms may design paid support or training for online freelancers to develop skills to adapt to changes in market and client demand or tools to scale and incentivize mentorship that provides critically absent social and informational support [35].

Supporting On- and Off-Platform Career Fluidity

As prior research hypothesized, our understanding of careers must be re-conceptualized to account for the digitization and fragmentation of work and careers [127, 241]. Our findings suggest a multitude of ways in which this is necessary. Specifically, our findings reveal that online freelance work is neither a straightforward alternative to a fully offline career nor a simple stop-gap source of livelihood while job seekers find offline employment. Rather, there is a critical emergent interaction between offline and online freelancing that necessitates expansion and re-conceptualization of our notions of career development and career trajectories in this new form of work. Concretely, the interaction between online freelance platform work and offline work emerged as critical component of many participants' career trajectories—for instance, influencing financial sustainability, career exploration, and skill development and transfer. We draw attention to both the opportunities and limitations of this interaction to investigate via future research, policies and tools.

First, our findings demonstrate how external legitimacy and portable reputation is a critical barrier to the interaction between on- and off-platform career development opportunities. For instance, internal platform reputation (e.g., reviews, ratings) and experience held limited signaling value or credibility for some participants as they attempted to transfer their experience across platforms or to a traditional employer. Prior research has focused

on supporting impression management [95] strategies among online freelancers through their online portfolio. Future research could investigate and design to support impression management techniques for online freelancers to effectively communicate and demonstrate their online freelance reputation (e.g., experience and skills) across and beyond online freelance platforms. However, platforms lack the incentive to support transfer as internal reputation systems keep freelancers and clients tied to the platform. Thus, our findings point to an overarching need to investigate partnership and policy opportunities to support reputation transfer. For example, future policy might be necessary to regulate public indicators of internal platform reputation and support platform credentialing and certification.

Second, our findings suggest that online freelance platforms often serve as an outlet to explore both online and offline career possibilities through acting as diverse job boards and vehicles for more rapid exploration. The potential for online freelance platforms to support career exploration is an increasingly important area of study given the relevance of career exploration in the rapidly changing future of work (e.g.,[154]). Yet despite the prevalence of career exploration among our participants, critical barriers remain. For instance, a low success rate finding work in a new domain due to the expert-centric design of online freelance platforms that does not support exploration, the absence of a team or mentor, or even negative client feedback, hampered the efficacy of participants' exploration. Recall P6 whose exposure to web design coding through her blogging gigs on Upwork enabled her to identify a new career of interest: software engineering. Yet to pursue this path further, she felt compelled to venture offline, where she could access support from a mentor and team during her career transition. Thus, as workers increasingly turn to online freelance platforms for career exploration and online freelancers adapt in the face of changing demand for certain skills, platforms and system designers should consider how to make career exploration and transition more accessible and effective given its growing rel-

evance to career adaptability [128]. For example, by integrating and extending career development research to provide accessible forms of career support and reducing the risks of exploration (e.g., [193, 154]), future platform re-design and tool development might assist freelancers to identify pathways, gain necessary skills and mentorship, secure opportunities (e.g., paid apprenticeship with other online freelancers) and access reliable feedback on their work in new domains.

Third, our findings suggest that some online freelancers leverage online freelance platforms to gain new skills and work experiences throughout their career, but particularly during constraining life circumstances, periods of unemployment, or when access to domain-relevant offline work is limited locally. In these situations, questions such as "What skills will be required, which institutions will provide them, who will pay the costs and who will have access?" [241] have heightened relevance. Community colleges, apprenticeship programs and online education, for example, have all been proposed as accessible solutions to labor market challenges. And yet, it is unclear if these solutions are indeed accessible to individuals turning to online freelance platforms, with their flexibility and precarity and additional overhead and constraints. Future work could introduce more tailored training opportunities by considering labor market challenges and interactions between online freelancing and off-platform employment.

Finally, our findings on the immense pressures and overhead of online freelancing suggest potential challenges of crafting and navigating a career across online freelancing and off-platform or offline work contexts. For instance, the pressure of managing the overhead of online freelancing often exacted burnout and required participants to become hyper-focused on simply sustaining their online freelance career in the short term. In this way, our findings support prior hypotheses about the increasing challenge, yet growing importance of construal-level ambidexterity, or "the ability to switch perspectives, specifically to zoom out to a higher level of construal to get a broader picture of one's job and career" for

gig workers [20]. Future research could further investigate macro-career-management challenges and opportunities for systems and tools to support careers crafted across offline and online freelance platform work contexts; for example, by scaffolding online freelancers' career development practices and reflection across work contexts.

Fostering Productive Client-Freelancer Relations

Our findings highlight the myriad of ways clients interact and influence online freelancers' career trajectories. On the one hand, our findings suggest that some clients can play a positive role in a freelancer's "developmental network" [126]. Yet, on the other hand, the power and information asymmetries between clients and freelancers [291], coupled with poorly incentivized (and largely absent) client socialization, placed a significant overhead on freelancers, particularly in the long term. Prior work suggests a number of challenges that might result from such relationships. For instance, psychological safety (e.g., shared belief held by members of a team that the team is a safe space for interpersonal risk-taking) and team-learning behaviors (e.g., seeking feedback, discussing errors) are important for satisfaction and performance in teams [90]. However, these behaviors can be hampered by large power differences and potential for retaliation—conditions often rampant in an online freelance context. Moreover, online freelancers are often forced to piece together information, such as context support and feedback, largely on their own, with little to no help from collocated clients or colleagues, while navigating informational needs often in high-risk contexts (e.g., presence of client power and information asymmetry in an online freelance context). Our findings thus highlight ample opportunity for future policy and design to mitigate the overhead of client-relationship management. For example, platforms could leverage their unique intermediary role to use natural language processing to provide real-time feedback and nudges to incentivize and scaffold effective mentorship behaviors, while also providing outlets for freelancers to recognize

and report unethical or rude client behaviors without relational or reputational repercussion. Another potential opportunity for platform redesign and tool development is highlighted by P4, who transitioned from working as a freelancer to primarily hiring on Upwork for her company, and was able to hire and work with freelancers more effectively after having been on the other side. While not all clients can achieve the same level of experiential understanding as P4, this example suggests some effective incentives for platform-based client training.

4.6 Conclusion

Chapter 4's findings folded into a larger ethnographic discourse on the role of offline peer networks created by independent workers, particularly by contributing an analysis focused on highly-skilled online freelancers' long-term pursuits. That these peer networks among workers are offline is not a coincidence, but instead is critical for in-person trust building when navigating sensitive issues and information asymmetries and providing emotional support. To better understand and further support workers' existing strategies and networks, such as the intertwining of online and offline networks, human-computer interaction scholars have emphasized the importance of finding and collaborating with existing organizations or non-profits which already amplify independent worker voices. Therefore, viewing community through a proximate lens, I considered existing spaces where independent workers gathered in Pittsburgh and built peer networks offline, such as Pittsburgh's many sites dedicated to digitally-engaged local entrepreneurs.

Part II

Co-Designing Peer Support Systems with Independent Workers

Part II Summary

In the next chapter, Chapter 5: "Participatory Action Research with Independent Workers," I aimed to better understand and further support workers' existing strategies and networks. Viewing community through a proximate lens, I considered existing spaces where independent workers gathered in Pittsburgh, such as Pittsburgh's many community sites dedicated to digitally-engaged local entrepreneurs. Together with my community partner, Community Forge, we co-designed a novel model for technical support among entrepreneurs, called Tech Help Desk. Tech Help Desk mitigated additional uncertainties of independent work by adapting to entrepreneurs' need for temporal and spatial flexibility and by prioritizing trust and relationship building between community members and researchers.

Alongside my work with Community Forge, in Chapter 6 "Co-Designing a Peer Support System with Independent Workers," I explored a collaboration with another community partner: a feminist makerspace in Oakland, PA called Prototype PGH which primarily focused on equity in technology and entrepreneurship. Building on Prototype's ethos that everything is a prototype and feedback is critical to success, I co-designed a mobile application, Peerdea, throughout a multi-year collaboration with Prototype. Because Peerdea leveraged existing relationships and in-person relationship building among independent workers, Peerdea was used as a trustworthy virtual space for workers to ask for advice and feedback, general information exchange, as well provide emotional support.

5 Participatory Action Research with Independent Workers

5.1 Overview

In Chapter 5, I followed a participatory action research protocol and collaborated with various stakeholders at an entrepreneurial co-working space, Community Forge, to investigate technical skill development for digitally-engaged local entrepreneurs—entrepreneurs who primarily target their local economy and rely on myriad digital tools to do so successfully.[1] Together, we created a novel model of on-going technical service for entrepreneurs called "Tech Help Desk", where local engineering students, postdoctoral associates, faculty and community members provided weekly technical support, in-person and remotely. Our model for technical assistance was strategic, in how it is designed to fit the context of local entrepreneurs, and responsive, in how it prioritizes emergent needs. From our engagements with 19 entrepreneurs and support personnel, we reflected on the challenges with existing technology support for local entrepreneurs from a lean economy. This chapter highlights the importance of ensuring technological support services can adapt based on entrepreneurs' ever-evolving priorities, preferences and constraints. Furthermore, we find technological support services should maintain broad technical support for entrepreneurs' long tail of computing challenges [173]. Together with Tech Help Desk, entrepreneurs addressed 61 distinct computing challenges.

[1] The published version of this work can be found in [173].

5.2 Introduction

Starting a local business can lead to individual and community benefits, including building long-term wealth, creating desirable nearby jobs, and addressing local needs [74, 220]. Today's local entrepreneurs must navigate an increasing array of technological tools to achieve their business goals (e.g., creating a polished website, syncing files with an assistant, scanning receipts to track expenses) [22, 106, 140, 189]. Ever-evolving technology requirements create particularly strong barriers for entrepreneurs in minoritized and resource-constrained communities [243] due to historical inequalities in financial, social, and more recently digital resources (i.e., the "digital divide" [229]). The COVID-19 pandemic accelerated technology expectations for local business owners [47, 216], magnifying the effects of existing technology barriers [25].

While decades of research and design efforts aimed to make the technology used by entrepreneurs less expensive and easier to use (e.g., WSYWIG website builders, social media, and desktop printing), technology barriers remain persistent for people in resource-constrained or "lean economies"[2] Recent work has explored technology support for workers from lean economies such as digital literacy classes for returning citizens seeking jobs [227], and social supports including workshops and meetings for entrepreneurs creating tours [140]. Such programs provided support for people with similar businesses or technical experience, but they may be less useful for entrepreneurs who have heterogeneous businesses, backgrounds and technology goals.

To understand and address the computing challenges faced by local entrepreneurs in a lean economy, we followed a Participatory Action Research [24] approach to design and run "Tech Help Desk", an on-going service[3] that provides technology help to local

[2]For the remainder of the chapter, we use "lean economies" as the preferred term which highlights the resiliency and innovation of residents located in communities with few resources as done in prior work [78].

[3]Tech Help Desk is an on-going project, but this chapter reports on two and a half years of progress.

entrepreneurs. Tech Help Desk was co-designed with community stakeholders from Community Forge: a local entrepreneurial hub that provides resources for local entrepreneurs in a small Midwest city in the U.S., Wilkinsburg, PA, including co-working space, accelerator programs, and community events. Tech Help Desk's *strategic* and *responsive* approach to technological support in the workplace uniquely provides need-driven technology support for immediate entrepreneur requests (e.g., uploading PDFs for business registration, or connecting to a printer or scanner for taxes). By extension, Tech Help Desk addresses a critical gap in the existing ecology–an ever-evolving collection of resources [290]–of local entrepreneurial support. During the design, deployment and study of Tech Help Desk, we asked the following research questions: *(RQ1)* What are the technology challenges faced by local entrepreneurs?, *(RQ2)* What are the existing resources and workarounds that local entrepreneurs use to overcome their technology challenges?, and *(RQ3)* What are features of technology support that may be more effective than common workplace approaches for technology support?

Our engagements with 19 local entrepreneurs and support staff revealed how local entrepreneurs were resourcefully and discerningly addressing their computing challenges by curating an ecology of support: building networks of trustworthy friends and mentors, seeking out business coaches, enrolling in business accelerators and courses. Still, the deployment of Tech Help Desk revealed 61 unique computing challenges that entrepreneurs were not yet able to address, due to a mismatch between support–or lack thereof–and entrepreneurs' technology challenges. We refer to this collection of 61 challenges addressed with Tech Help Desk as the *long tail* of computing challenges, given the large number of distinct challenges that were surfaced and solved. For instance, a single local entrepreneur used Tech Help Desk services to address a range of technology challenges including: freeing storage space, editing a PDF document, posting to a listserv, navigating local files, learning keyboard shortcuts, removing malware, setting up cloud

services, accessing necessary hardware, automating social media posts, and updating products on a website. In total, we worked with entrepreneurs to address 61 unique computing challenges across 35 distinct computing tools (e.g., website builders such as Wix, Squarespace, or WordPress, financial software such as QuickBooks, cloud services such as Google Drive, social media platforms such as TikTok and Instagram, payment tools such as Venmo, content editing tools such as Canva and Adobe, and so on). Tech Help Desk's strategic and responsive approach was critical to match the local entrepreneurs' resourceful and discerning approaches to growing their business in a digitized landscape.

This chapter makes the following three practical and conceptual contributions. First, drawing on our participatory approach, we present a model of technical support that addresses key design tradeoffs for entrepreneurial support and, as a result, is strategic in how it is attuned to local entrepreneurial contexts, and responsive in how it dynamically prioritizes emergent needs (See Table 5.1). Our work demonstrated that strategic and responsive support in the form of flexible and personalized one-on-one sessions was critical to matching entrepreneurs' discernment (e.g., balancing learning goals with the demands of running a small business), where we recognized the wealth of resourcefulness they already possessed. Second, we offer a detailed case of this model through Tech Help Desk, illustrating how this strategic and responsive form of support can help address the many day-to-day computing challenges entrepreneurs need to overcome (i.e., the long tail of computing challenges). Third, towards practicality, this chapter also contributes a deep investigation of other entrepreneurial support approaches and programs within the region and how our strategic and responsive model of technical support, instantiated in Tech Help Desk, fits alongside. Together, we present a detailed illustration of how resourceful and discerning entrepreneurs often stitched together multiple programs, social networks, and other resources to address their technical needs (i.e., their ecology of support). This will inform researchers' and community partners'

Table 5.1. A model for technology support that can be strategically attuned to entrepreneurial contexts and is responsive to the preferences and needs of local entrepreneurs (Design Tradeoff). In our implementation of this model, our participatory approach informed the design choices (Choice) and how Tech Help Desk embodied these choices (Instantiation) within Community Forge.

Model of Strategic and Responsive Support	**Tech Help Desk**	
Design Tradeoff	Choice	Instantiation
Should we provide responsive or standardized support?	Responsive	Individualized support
Should we prioritize learning or problem-solving?	Learning	Side-by-side format
Should we assume recipients' trust or build trust actively?	Build trust actively	Relationship building with consistent providers & times
Should we present as technical authority or knowledgeable collaborator?	Knowledgeable collaborator	Knowledgeable, but disclose bounds of expertise
Should we provide one-off or on-going assistance?	On-going	Drop-in, but encourage appointments
Should we prioritize visibility or privacy?	Visibility	In-person (when possible), in common area

understanding of entrepreneurial computing challenges and, by extension, will help to design services and tools to enable local entrepreneurs to thrive in their local economy and beyond.

Resources for Entrepreneurship

Entrepreneurship research suggests that a business is more likely to be successful if the entrepreneur possesses individual skills and characteristics relevant to starting their business (i.e. "human capital") [208], and social support for networking, information gathering and emotional needs (i.e."social capital") [42, 205]. Human capital for entrepreneurship includes a broad range of knowledge [187] gained through work experience, education, and entrepreneurial experience [208] as well as personal and psychological factors such as self-efficacy, social skills, health and motivation [78]. Social capital relevant to entrepreneurship includes personal networks and formal or informal groups to which the entrepreneur has access (e.g., government, bank, or community-driven organizations, and inter-community or extra-community ties [55]). For people in lean economies, access to both social and human capital (as well as financial capital) can be limited [22, 55]. In such communities, many turn to entrepreneurship out of necessity to make a living, i.e. "necessity-driven entrepreneurship" [142] rather than "opportunity-driven entrepreneurship" [288] — the notable difference between being whether people can opt in or opt out to entrepreneurship. Access to general resources for entrepreneurs remains a challenge for "low-wealth" entrepreneurs [55]. To better

support entrepreneurs pursuing necessity-driven entrepreneurship, there exist calls for flexible funding opportunities [214], entrepreneurship education [218, 225], and incubator opportunities to facilitate social capital growth. In this chapter, we explore how to build human capital to overcome barriers to entrepreneurship–specifically technological barriers–within an environment dedicated to entrepreneurs' social capital growth.

Entrepreneurial Skill Building for Using Technology

Research suggests that digital literacy is a form of human capital that is unequally distributed [243]. Digital literacy—or, "the ability to use information and communication technologies to find, evaluate, create, and communicate information" [21]—requires not only low-level skills for operating a specific technology (i.e."operational", or "medium-related" skills [18, 275]), but also higher-level skills that relate to the selection and strategic application of technology to reach a goal (i.e. "content-related" skills [275]). Prior work aimed to understand the types of technology challenges faced by entrepreneurs in lean economies using technology for business goals [78, 140, 142, 227, 229, 238].

In particular, scholars engaged in participatory action research [24, 123] explored non-technical approaches to facilitating digital engagement which rely heavily on structures of social support such as peer learning [227, 229]. Peer support approaches are particularly beneficial as, by definition, peers have shared experiences which can to provide more contextually-relevant information [122]. Ogbonnaya-Ogburu et al. established a digital literacy class for returning citizens seeking jobs [227], and Pei and Crooks established a class for introducing tablets into an English as a Second Language (ESL) class [229]. In the context of entrepreneurship, Hui et al. introduced social supports (e.g., in person meetings, paper prototyping, tour practice) for entrepreneurs developing tour businesses [140]. To showcase pride in one's local community, Dillahunt et al. facilitated opportunities for entrepreneurs to grow local tour businesses (e.g., by setting the platforms and

technical requirements for the tours) [78]. This work uncovers highly-detailed accounts of the technical barriers specific to certain domains such as tour businesses. However, classes and group activities may work better when business goals are homogeneous rather than diverse as these standardized formats of assistance leave less room for customization [155]. To address and adapt to the needs of entrepreneurs who run heterogeneous businesses at differing levels of maturity, we design a model for strategic and responsive technical support for resourceful and discerning entrepreneurs.

Technology Support in the Workplace

While support structures for local entrepreneurs is an emergent field of study, a range of approaches have been explored to assist employees in overcoming their technical woes including both formal (help desks, IT consultants) and informal methods (over the shoulder learning or water cooler troubleshooting among peers). For instance, Novick et al. conducted interviews and participant observation among knowledge workers to understand how employees resolve their technical issues [224]. They found half of the time people asked colleagues and the other half of the time people went to their organization's in-house help desk. These help desks provided full-time employees who were dedicated to resolving their organization's technical woes. Yet formal help desk providers were pressured to maintain an unwavering sense of technical expertise (e.g., to inspire confidence with prepared answers [116], and achieve performance goals [33]). Moreover, organizational help desks often focus on repeat problems, and may not fit entrepreneurs' diverse technology needs. Moreover, as a result of organizational incentives and pressures, help desks may foster reliance on the service rather than resilience to future computing challenges (a critical skill when resources are ever-changing).

Several scholars have investigated the benefits and drawbacks of peer learning when addressing computing challenges in the workplace such as among teachers [277] and knowledge work-

ers [274]. For example, Twidale focused specifically on informal learning–water cooler exchanges [284]–among knowledge workers resolving technical issues and found that peers provided a helpful organizational context when addressing their colleague's technical issues [274]. When offering technical support in these informal exchanges, employees providing assistance assumed one of two roles: a "guru", where their deep technical understanding led them to the solve their colleagues' challenges quickly [104], or, a "gardener" or "translator" role where their approach was more collaborative [203]. While understanding role playing behaviors among knowledge workers provides critical insight into informal technical assistance within formal workplaces, our setting of a co-working space for entrepreneurs has important differences which may affect informal technical support. For instance, entrepreneurs do not work for a shared organization, and they therefore often do not have colleagues, standard expected working times, nor a shared organizational goal. Given this isolation, it may be challenging for entrepreneurs to form a network of peers from which to seek technical assistance. If an entrepreneur does have access to a network of peers, entrepreneurs must weigh the benefits of receiving help alongside reputational concerns, as asking for help from peers can result in being perceived as less knowledgeable [180]. In this chapter, we explore an approach to providing entrepreneurs with technical assistance that does not rely on peers by default.

One-to-One Instruction and Technology Support

Beyond the workplace, one-to-one instruction is one of the most effective approaches to education [38]. In formal educational settings, learning is *curriculum-driven* such that all learners first receive the class curriculum that covers necessary knowledge, then learners are provided increasingly targeted support for learning that curriculum through group or one-to-one instruction [23, 64, 102, 136]. Unlike reading and math, technology skills (e.g., typing, spreadsheets, document processing) are not part of standard U.S. curriculum, so students are unlikely to receive one-to-one

support. Outside of primary and higher education, people can enroll in coding bootcamps, but such services do not offer education for the broad technology knowledge that it takes to be a local entrepreneur [199, 266].

Instead, people often learn technology for their personal goals in-situ while working on a task, rather than through any set curriculum. To support learning expert software or how to code, prior work has explored ways to remotely connect people to experts or peers with relevant technical knowledge [60, 61, 158]. Joshi et al. connect users of specialized help with another person who uses the software for three minute one-to-one help sessions [158], and Codementor matches students to long term mentors for feedback on writing code [66]. The side-by-side approach of a person screen-sharing while another person serves as a side-kick (rather than the expert fixing the problem directly), can benefit learning and the work itself [26, 117]. Alternatively, tool-specific support forums (e.g., Photoshop Guru, reddit.com/r/photoshop, Adobe Support Community) offer Q&A-based asynchronous peer support. As formulating a query or supplying relevant information [256] is challenging without domain knowledge, some tools propose to help surface general-purpose answers to Q&A in-context of tool use [61, 212]. These tools provide powerful guidance for technology use, yet require downloading a browser extension [61] or setting up additional software [212]. In lean economies where access to technology and technology literacy may be limited, recent work highlights the importance to consider non-technological solutions to facilitate technology use (rather than addressing technology challenges with more technology) [140]. For instance, library staff members can provide in-person one-to-one support for people performing tasks on library computers including seeking jobs or accessing government services [31, 267]. In addition, recent work in human-computer interaction research by Hui et al. provided in-person ("low-tech") technology support for entrepreneurs creating tour businesses [140].

Overall, the broad and goal-oriented technical needs of local

entrepreneurs (e.g., "launch a website myself", "keep track of my customers") fall outside of the scope of the purpose, expertise, and time that existing structured services provide — either due to their focus on a specific technology tool or specific goals. In this chapter, we explore: the long tail of technology challenges that are not yet addressed by technology-based or social supports, and (2) how to tailor one-on-one support to meet the business needs of entrepreneurs in lean economies.

5.3 Method: Multi-Year Participatory Action Research

Informed by the needs of a local hub for entrepreneurship, we hosted a two and a half year long (and on-going) service providing broad one-on-one help for local entrepreneurs, called "Tech Help Desk". The findings we report are based on the design of and observations during Tech Help Desk sessions along with interviews with local entrepreneurs and others who provided services for local entrepreneurs.

Location and Site

We conducted our research within a co-working space and community hub for local entrepreneurs based in Wilkinsburg, PA called Community Forge (See Figure 5.1).

Wilkinsburg, PA Wilkinsburg, PA is a borough of Allegheny County, PA. The population of Wilkinsburg, PA is roughly 68% Black and 35% of people are living at or below the poverty line [11]. Wilkinsburg, PA immediately borders but is not part of Pittsburgh, PA, and it is one of the many unincorporated municipalities that acutely struggle with resource deprivation and long-term disinvestment [1]. In 2021, Pittsburgh, PA was considered to be one of the U.S.'s "Apartheid Cities" [7], as the structures of power within the city continue to perpetuate systemic racial inequality and injustice [211], magnified by the post-industrial blight the region

experiences.

Community Forge Community Forge is a former elementary school re-purposed into a space that hosts mixed programming geared towards developing a more equitable economy for Wilkinsburg, PA and the Greater Pittsburgh, PA region (Figure 5.1). Towards this goal, Community Forge provides financial resources, jobs, job training, business development, youth empowerment programs (e.g., courses, summer camps, hands-on-learning), and community outreach events (e.g., food and supply giveaways, music and movie nights, hosts a voting location). Community Forge's business development resources include: coaching and professional service referrals, technical assistance, networking opportunities, financial support, and affordable office rentals (repurposed classrooms with co-working and individual office space, Figure 5.1B). Community Forge works with roughly 50 local businesses each year through a variety of programs where 95% of the businesses are Black-owned, approximately 90% of entrepreneurs do not have a college degree, and 80% are first-time entrepreneurs. To spread information about resources available within the space, Community Forge relies on word-of-mouth and social media, as well as working with existing organizations in Wilkinsburg, PA and Pittsburgh, PA which support entrepreneurs. Community Forge also hosts quarterly tenant mixers, where the entrepreneurs renting space at Community Forge can mingle, enjoy free food, share updates and hear any announcements with the space.

***Business Bloom Program* at Community Forge** Community Forge provides an intensive, year-long incubator program for entrepreneurs called the *Business Bloom Program* that provides financial resources, professional services, and strategic consulting to small business owners. The *Business Bloom Program* also connects entrepreneurs to its network of accountants, attorneys, business coaches, technical support (Tech Help Desk), graphic designers, and–during COVID-19–public health consultants. The stated goal of the *Busi-*

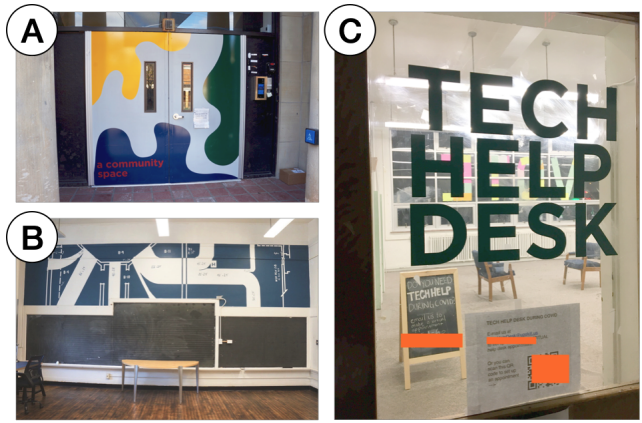

Figure 5.1. Photos depicting (A) the front entrance to Community Forge, (B) one of the classrooms in Community Forge, and (C) the Tech Help Desk room.

ness Bloom Program is to assist small businesses in keeping up with the demands of an ever changing COVID-19 business landscape while serving and fostering the growth of minority-owned enterprises.

Co-Designing Tech Help Desk

Initial collaboration between Community Forge and the researchers' university began when one member of the research team reached out to leaders at Community Forge to introduce himself and to gauge and establish interest in collaborating for a grant proposal[4]. In these initial discussions, community stakeholders emphasized that it was important that our presence within Community Forge brought immediate value for the community members. The directors were clear that starting with any form of data collection immediately upon entering the space would not be permitted, as such an action would extracting value from the space without providing anything in return. This concern echoes previous

[4]The grant proposal focused on leveraging existing community structures to facilitate job mobility within underserved communities (urban and rural) by training unemployed individuals to become online workers.

calls to prioritize rapport building [188] and to deliver immediate value to stakeholders by prioritizing their needs rather than optimizing for a research agenda when conducting community-based research [271, 120]. Community Forge leaders also emphasized the tenuous historical relationship between the researchers' institution and the surrounding community that Community Forge served. For instance, the researchers' institution had a history of being complicit to the racial injustice in the surrounding area, such issues ranging from public relations [8] to police brutality [9]. Therefore the resulting lack of institutional trust needed to be taken into account when considering next steps.

In June of 2019, we began our discussions with Community Forge members for how the researchers could address challenges the entrepreneurs in Community Forge were experiencing. Community Forge leaders and researchers suggested a few ideas for how the research team could structure their involvement with the space. One idea was to offer a series of courses on technical skills, but given the diversity of entrepreneur businesses within Community Forge, it was not yet clear what technical skills a curriculum should cover. A second idea (similar to the original grant proposal) was to provide a class on how to find jobs within online labor markets such as Fiverr or Freelancer to facilitate job mobility, but few entrepreneurs in the space were interested in pursuing online freelance work alongside running their small business. Another idea was to provide a tool to facilitate peer mentorship among entrepreneurs at Community Forge, but the director of the peer mentorship program did not consider it appropriate to conduct a research study on peer mentorship as they were just establishing peer cohorts within Community Forge. As conversations deepened, the Community Forge executive director shared their experience working on day-to-day computing challenges entrepreneurs would come to them with. As the director had a tight schedule, such requests for one-on-one technical assistance were leaving them exasperated. These reflections, coupled with recommendations from leaders of other entrepreneurial non-profits (e.g., a director

for a leading technology non-profit in the U.S.), led to a consistent starting point: to offer "office hours" in which research team members could answer *any* technical questions while physically present at Community Forge. Regular office hours would allow the research team to provide immediate value for Community Forge and enable relationship building. Community Forge leaders and the researchers agreed that repetition and consistency would be important to build a reliable presence within the space. After three months of discussions and iteration, in September 2019, we opened weekly "office hours" for entrepreneurs in the space, called Tech Help Desk.

When determining how to advertise Tech Help Desk, we considered how to communicate the types of technical services we would offer. This was a non-trivial task not only because of the need to keep the call as broad as possible, but also because those who the call was targeting did not necessarily know the technical jargon used to articulate and identify technical issues [169, 287]. Therefore, we did not list a fixed set of technical tasks our providers would offer, but instead left this call open and welcomed all technical challenges. However, during the study, this open-ended call caused confusion as entrepreneurs did not know what type of services Tech Help Desk provided. In the end, we created a flyer describing all the services providers had offered (See Appendix).

Timing and location within the building

To determine time and location of Tech Help Desk, we discussed with Community Forge's Operations Manager, who was a constant presence in the facility and had the most in-depth understanding of who was at Community Forge and at what time (including co-occurring programs). As entrepreneurs were most likely to be in the space midweek and midday, we selected Wednesdays 12:00PM-3:00PM for the winter months and 1:00PM-4:00PM for the summer to account for the change in daylight. For the physical location of Tech Help Desk, we initially set up in the atrium, a central area where all tenants pass through when entering or leaving the

building. We also tried renting a desk in a co-working room (but it was difficult to share sound space with entrepreneurs who sought quite time at their desks) and a renting a full room (which provided privacy for support sessions). In the end, we returned to the atrium as it afforded the best discoverability of the service.

Tech Help Desk Structure and Activity

Entrepreneurs discovered Tech Help Desk through flyers we posted with the monthly schedule throughout the building (See Appendix), word-of-mouth from prior participants, Community Forge staff, Community Forge newsletters sent monthly, as well as through physical encounters within the space (i.e., walking by the desk). The Tech Help Desk providers traversed the space to introduce themselves to other members and inquire if they had any technical issues. Once initial contact was established, the provider worked with the entrepreneur to determine if an in-person or virtual session would best fit their needs, and if they preferred to schedule an appointment or walk-in (when COVID-19 restrictions were in place and all appointments were remote).

For the session, we asked entrepreneurs to bring a device and charger they could easily access these. If they did not have access to a WiFi or data-enabled device, the computer lab within Community Forge provided devices. Entrepreneurs were given the option to opt into the research study, and it was made clear that participation in the research study was not required to receive technical assistance. To help mitigate any pressure entrepreneurs felt to opt in to the study, it was mentioned as a secondary point and deproritized alongside the other intake information provided to the entrepreneur. In addition, we also encouraged any questions and provided transparency into the research questions and research goals. Tech Help Desk sessions were not recorded, but instead the provider took field notes during and after the session. While note taking, the participant could view the provider's screen (when the session was in-person) and see the notes and ask questions. After the session, the provider asked if the entrepreneur

would like to schedule a follow-up meeting. The provider then sent a follow-up email describing the tasks accomplished in the completed session, "to do" items the entrepreneur should attempt to accomplish between sessions, and goals for the next session.

Responding to COVID-19

In response to the COVID-19 pandemic, we transitioned Tech Help Desk to remote assistance via Zoom or phone starting in March 2020. All participants of Tech Help Desk had Zoom installed on their devices and were comfortable with using Zoom, but two participants preferred a phone call for an initial consultation. In Zoom sessions, participants shared their screen via Zoom, but they were not able to see the provider's screen. We expanded the hours participants could request a help session to Monday - Friday 9:00a-6:00p, acknowledging the heightened stress and demand on entrepreneurs to have a strong digital presence for their small business as a result of the pandemic. When Community Forge reopened in July 2021, the research team returned to offering in-person Tech Help Desk sessions, but continued to offer remote Tech Help Desk sessions for those who preferred to meet online.

Leading up to and Following the Tech Help Desk session

A pre-session survey asked participants to provide details about their technical questions, their business, their demographics, and whether their business was their main source of income. A post-session survey asked participants to describe the solution implemented with the provider, as well as to provide positive and constructive feedback on the session with the "I like..." and "I wish..." format [121].

Interviews with Entrepreneurs and Supporters

To gain a rich, qualitative understanding of how local entrepreneurs overcome everyday technology challenges, we conducted semi-structured interviews with Community Forge entrepreneurs as well as people who have supported Community Forge entrepreneurs

(e.g., program directors, business coaches). We conducted our interviews between February 2020 and summer of 2021. We began our outreach for interviews in February of 2020, but the COVID-19 pandemic removed all possibility of interviewing entrepreneurial support personnel. We resumed and completed interviews in the summer of 2021.

Participants

We recruited entrepreneur participants by emailing entrepreneurs who had used Tech Help Desk or participated in the *Business Bloom Program*. We also recruited Community Forge leaders and people who served in support roles for the *Business Bloom Program* program (e.g., business coaches, lawyers, accountants, web developers), as well as people who led or served in support roles at other incubator and accelerator programs for local entrepreneurs in Pittsburgh, PA . In total, we recruited nine entrepreneurs, and 10 support people (seven support people also owned their own small business) (See Table 5.2).

Semi-Structured Interviews

Our semi-structured interviews with supporters and entrepreneurs took one hour, and participants were compensated $20. We asked entrepreneurs background questions about their business, the types of technology they used as part of their business (e.g., websites, software, hardware, cloud services, and social media), and types of external help they used. We then asked about what types of technical challenges they encountered as a business owners and how they overcame them. We concluded with asking about what resources they would like in the future for solving technology problems. During interviews with people in supporting roles for entrepreneurs, we asked about their organization and the types of entrepreneurial support it provided (e.g., educational, financial, or technology resources). We then asked about their experience with entrepreneur technology challenges and solutions, and about any

resources for learning technology they felt were missing. Please see the Appendix for both interview protocols.

Data Analysis

For the semi-structured interviews, the research team conducted audio and video recording and took detailed field notes. All audio recordings were transcribed (with Descript.com) and reviewed for errors by hand. The research team analyzed these data through a process of open coding to identify initial themes across the interviews and the Tech Help Desk field notes. We later engaged in affinity diagramming [56] over the course of two weeks, where the three out of six authors reviewed each transcript, marked sections that informed and extended this chapter's motivations, and printed out the corresponding raw data. Clusters formed around key themes: barriers to using computing tools for entrepreneurs (and whether these barriers were "content", "operational", or "access" challenges [275]), resourceful workarounds entrepreneurs deduced to overcome barriers, systems of support and entrepreneurs used to facilitate the use of computing tools in their business. All authors repeatedly met during this period to review key findings and iteratively refine a set of analytic memos which expanded on themes emergent across our data [56]. We followed participant quote editing conventions consistent with applied social science research practices [68]. Specifically, we removed filler words and false starts, in some cases re-punctuated and used ellipses to indicate substantial omissions.

Positionality

We disclose the identities and positionality of the researchers and authors of this chapter, as a concern for reflexive design research practice [194, 249]. Tech Help Desk sessions were led by a research team comprising three white women, one from the Southwest U.S., one from the Southeast U.S., and one is a U.S. immigrant from Western Canada; two white men from the rural Midwest of the U.S.

and an impoverished, post-industrial part of Eastern U.S.; and one Black man from Eastern U.S whose work focuses on business development, who is dedicated to providing economic opportunities for minority entrepreneurs, and who has experienced racism firsthand during his time in "Corporate America". The research team comprises three researchers who are upper management at the field site, three researchers in a technical department at a private U.S. university (a graduate student and two faculty members, one tenured and one un-tenured), one un-tenured faculty member in a technical department at a public U.S. university, and one individual who ceased their pursuit of a technical career in academia in order to center their community-based efforts to fight the tangible inequities caused by racism, poverty, and devaluing of human life in the U.S.

The five middle-aged, white researchers do not have certain lived experiences that are relevant to this study such as the impact of forms of violence due to racism, ageism, or xenophobia (especially in the context of technology education). Three researchers do not have lived experience of poverty or other aspects of background that employers (or those funding business grants) discriminate against. All five white researchers experience privileges from whiteness, access to formal technical education (e.g., engineering and computer science degrees) and grew up with access to computing devices.

Given the predominantly white research team, we took measures to mitigate power imbalances and to cultivate a more equitable relationship between the research team and Community Forge members (as well as within the research team). For instance, all members of the research team were firmly committed to the Community Forge mission statement, prioritized generating immediate value for the community members rather than optimizing their research agenda, maintained transparency with research practices, depriorizted data collection, and routinely sought feedback from Community Forge members and staff for how to improve Tech Help Desk.

Table 5.2. Tech Help Desk and interview participant demographics. Participants were able to opt-out of sharing any aspect of their identity. All but four entrepreneurs who leveraged Tech Help Desk were sole proprietors of their businesses, and the other businesses had less than five employees.

PX	Gender	Business Category(ies)	Participant Type
P1	Woman	Community Development	Supporter
P2	Man	Lifestyle and Youth Motivation	Entrepreneur
P3	Man	Law	Supporter
P4	Man	Music and Entertainment	Entrepreneur
P5	Man	Community Development	Supporter
P6	Woman	Peer-to-Peer Support	Supporter
P7	Man	Music and Entertainment	Entrepreneur
P8	Man	Community Development	Supporter
P9	Man	Housing and Development	Entrepreneur
P10	Man	Business Development	Supporter
P11	Woman	Community Development	Supporter
P12	Man	Law	Supporter
P13	Woman	Finance	Supporter
P14	Woman	Bakery and Confections	Entrepreneur
P15	Woman	Community Development	Supporter
P16	Woman	Gifts and Party Planning	Entrepreneur
P17	Woman	Estate Settlement and Food	Entrepreneur
P18	Non-Binary	Events and Entertainment	Entrepreneur
P19	Woman	Stationary and Homeware	Entrepreneur

To build relationships with Community Forge entrepreneurs, the first and last authors attended the quarterly tenant mixers hosted by Community Forge. Research team members spent mixers introducing themselves to tenants and asking entrepreneurs what kinds of technology questions, goals, and challenges they were experiencing. Community Forge staff served as an intermediary for some of these introductions, in order to provide context to tenants for the research team's presence within Community Forge and to facilitate trust building.

5.4 Findings: On-Demand Technical Support for Independent Workers

Entrepreneurs Resourcefully and Discerningly Stitch Together an Ecology of Technical Support

We share the ways that entrepreneurs resourcefully and discerningly sought technical support to demonstrate entrepreneurs' ability in solving technical challenges. In addition, we detail the entrepreneurs' ecology of support to make salient the on-going technical challenges that are not yet addressed, illustrating the need for a strategic and responsive model of technical support to match the approach of the entrepreneurs. Overall, entrepreneurs identified and used a range of services to overcome computing challenges including: courses and workshops, social support including peers and mentors, as well as one-on-one support from business-related professionals (e.g., accountants, business coaches).

Courses and Workshops

Several entrepreneurs participated in business courses which were offered at local universities, public libraries, private companies, non-profits, and online. P11, a entrepreneurial support personnel, reflected that offering workshops allowed for larger reach for topics when providers need to *"tell everyone the same thing"*. P14 who ran a food business participated in seminars run by a local non-profit covering foundational business questions and technology (e.g., What type of customer are you trying to attract? Will you use cash app or Venmo to accept payments?) This enabled her to immediately improve her use of the technology she was already using (e.g., by using analytics on a social media app).

However, classes did not always line up with entrepreneurs' goals (reported by P1, P5-6, P9, P11, P15). In practice, entrepreneurs' technology needs were time-sensitive and dependent on business stage, domain and their existing knowledge. Further, general-audience classes offered through public libraries and universities were less useful as they were not tailored to the entrepreneurial

context (e.g., P11 noted that a general Excel course at the library did not cover how to use Excel for accounting – e.g., templates or formulas for creating a profit and loss).

Even if material in classes may be eventually be useful to their business, entrepreneurs often opted to spend their time on their immediate business tasks instead, as: *"[Entrepreneurs] might've forgotten [the class material] by the time they have that need, especially if it's not required, [and then] they won't attend a session until the need is there."* (P1). Still, P4 who noted that 80-90% of course content tended to be redundant, strategically tuned in through less relevant content because *"there's always something in there you didn't know"*. To use courses to meet their business goals, entrepreneurs planned to take specific classes when they reached that business need (e.g., P7 planned to take a QuickBooks accounting software class once they outgrew paper filing) and wished for regular local technology classes with on-demand access (P14).

Social Support: Peers and Mentors

Entrepreneurs identified informal opportunities for technical support through their own networks, and incubator or accelerator-style programs. Several entrepreneurs reported that they had a network of a few trusted peers or mentors with similar businesses tasks who they could contact to work through specific technology challenges. Peers or mentors with similar businesses could provide highly domain-specific technical help, as P4 described seeking on-demand technology support for a last minute filming job from a peer who was on a commercial shoot: *"I kept calling and he went on FaceTime and he went through all the settings [and] he told me what to punch in."* Peer support also provided one-on-one help to work through well-known technical problems with a better approach. P7 described that he contacted his website's company after running into a problem connecting his domain name (a common issue, P1, P6), and the company emailed back instructions for how to resolve the problem. However, P7 still ended up calling his friend to discuss the instructions due to their shared experience,

mutual understanding and trust. While peer and mentor support was valuable for entrepreneurs addressing their computing challenges, existing networks did not always have the specific skill needed (e.g., P7 did not know anyone who used a highly specialized music platform), and busy entrepreneur peers have limited time to provide support (e.g., P4 sent his peer a gift for providing last-minute tech support). As a result, entrepreneurs desired technical assistance which was available on-demand, as well as ways to expand their peer networks. To do so, several entrepreneurs participated in incubator-style programs in which they could meet other entrepreneurs.

To create opportunities to build social support relationships among entrepreneurs which endured, program leaders emphasized the importance of in-person interactions such as in-person co-working, mixers, barbeques and pitch competitions (P1, P5-6, P8, P15). Building new relationships in-person provided entrepreneurs with more information about potential support from peers or mentors. For example, P2 preferred to meet only in-person for technology support, as physical aspects like body language were important for him to find signals of trustworthiness. These in-person events were also critical to combat the isolation entrepreneurs can experience: *"We just really want to emphasize [getting] comfortable speaking about their business"* (P8). However, when it came to constructing cohorts of peer entrepreneurs through incubator-style programming, program leaders emphasized difficulties that can arise. For example, curating peer cohorts was challenging (P5-6) as a single cohort member can impact the efficacy of the whole group if there were clashing personalities, competing business models, or personal issues.

One-on-One Technology Support with Business Professionals

Entrepreneurs in our study also identified opportunities for technical support while completing other business tasks with professionals (e.g., business coaches, accountants, lawyers and web developers). They accessed such professionals either through an

incubator-style program or through hiring them for a specific job (e.g., to complete taxes, to file for incorporation). For the most part, business coaches did not provide support for low-level technical challenges (P6, P10, P12, and P15), but would provide higher level feedback on how to use technology to reach business goals (e.g., whether or not to build a website - P10).

Addressing the Long Tail of Computing Challenges with Tech Help Desk

While the ecology of support entrepreneurs resourcefully created addressed many of their technical challenges, there were still computing challenges that entrepreneurs were not able to readily address given a mismatch in the design of these support structures and entrepreneurial needs. In this section, we describe the 61 computing challenges entrepreneurs addressed with Tech Help Desk to further illuminate the need for strategic and responsive technical support. We refer to this collection of 61 challenges addressed with Tech Help Desk as the *long tail* of computing challenges, given the large number of unique challenges that were solved. We categorize challenges into: (1) *operational* challenges (related to the specific tool at hand, similar to "medium-related" challenges in [275]), (2) *strategic* challenges (related to the strategic selection and application of tools to a specific goal, similar to information and strategy in [275]), and (3) *access* challenges (related to balancing technology costs in time or money with other business expenses). To examine the importance of our side-by-side approach which informed the discoverability of challenges, we distinguish between challenges that were *self-diagnosed* (an entrepreneur-identified issue) versus *collaboratively diagnosed* (both entrepreneur and provider working together to uncover needs).

Self-Diagnosed Challenges were Mostly Operational Challenges

Entrepreneurs sought support when they self-identified technical challenges that blocked progress towards a business goal. Of the 34 unique technology challenges that entrepreneurs presented to

providers (i.e., self-diagnosed), 19 were operational challenges, 12 were strategic challenges, and three were access challenges. Self-diagnosed operational challenges indicated that a tool did not clearly communicate how to execute desired tasks, suggesting opportunity for improvements to technology design. The 19 operational challenges were related to: the entrepreneurs' websites (P1-2, P5, P7, P14-17), generating digital content (P1-2, P4-9, P11, P15-17), and other types of general hardware and software challenges (P1-3, P5, P6, P8-13, P15-19). For example, as all entrepreneurs in our study used a website service provider (e.g., Wix, Squarespace, Wordpress), many sought assistance with operational challenges related to these platforms in order to: upload video and photos to their website (P2, P14), navigate an online product dashboard (P2), update branding (P16-17), customize a blog post template (P2), add new product listings to online store (P2, P15-17), understand surprising web tool behavior (e.g., why a customer was charged a high price for shipping for an order placed in their website, P2), and to fix expired security certificates (P7, P11). Entrepreneurs generating digital content sought support to edit videos and photos of merchandise (P2, P4, P7) and to create or edit an existing PDF flyer (P5, P9). Beyond websites and digital content, entrepreneurs sought help for general software and hardware challenges including: downloading software (e.g., Microsoft 365 - P9, Quickbooks - P1, P5), improving device performance (P2, P9), locating software features to complete task at hand (P1-2, P5, P9), and forwarding calls to business phone (P18).

Self-diagnosed *strategic* challenges represented times where entrepreneurs proactively sought out advice on how to effectively use technology towards their business goals. The 12 self-diagnosed strategic computing challenges included: understanding the norms of use for computing tools such as social media platforms (e.g., when/what/how to post) (P9-10, P12), selecting between several options for tools to use (e.g. which website provider or financial software (P13, P17), determining credibility and trustworthiness of computing tools (P2, P9, P16), and building the confidence

to make technological decisions that could greatly impact their business (e.g., publishing a new version of their website (P16)).

Access challenges represented that resources should be easier to acquire including fast and flexible capital opportunities [214] and on-demand technology lending. The three access challenges that entrepreneurs shared were: paying for maintenance costs of websites and other software programs (P1, P2, P16), having reliable access to equipment (vinyl, laser, etc) (P15), and having reliable access to data and wifi-enabled devices (P15).

Computing Challenges Entrepreneurs and Providers Collaboratively Identified

We found that entrepreneurs' demanding schedules made spending time optimizing their use of technology to be in competition with time spent completing essential business management tasks. Thus, collaboratively identified challenges (27 of 61 challenges in our data) presented as moments of recognizing opportunities for improved technology use–or disuse. The 15 (out of 27) strategic challenges identified by entrepreneurs in collaboration with providers included: discovering helpful tools for the task at hand (P1, P5-6, P10-11, P13, P17), considering whether or not to prioritize use of computing tools alongside other business demands (where entrepreneurs often realized that they needed to demote the prioritization of computing tools in order to ensure strong business foundation (P1, P3, P5, P8, P10-13)), optimizing for a minimum viable website (rather than overextending their already limited resources to use more advanced technology (P3, P10, P12)), deciding how much time to spend acquiring computing skills for tools they already use to become more expert versus allocating time learning other tools (P1, P3, P10, P12), and planning their tool usage as their business grew. Beyond the strategic challenges, there were 12 *operational* challenges which were collaboratively identified between entrepreneur and Tech Help Desk provider such as how file types impacted uploading ability to online platforms (P5), management of multiple devices and file sharing across devices

efficiently (P2), and implementing effective website design principles (P2, P16-17). These collaboratively identified operational challenges indicated that a technology tool was likely inadequately equipped to provide error messages and recognize opportunities for improved use.

By distinguishing the types of challenges entrepreneurs addressed alongside whether the entrepreneur identified them (self-diagnosed) or worked with a provider to identify them (collaboratively diagnosed) illuminated how a side-by-side approach can facilitate further discovery of an array of computing challenges through mutual observation during Tech Help Desk sessions. Operational challenges were more likely to be observed by entrepreneurs themselves, as opposed to strategic challenges which were more likely to be identified with the providers' assistance. In the discussion section, we reflect on why this may the case. In the next section, we detail three entrepreneurs' experiences using Tech Help Desk to address their long tail of computing challenges.

Three Vignettes: Addressing Computing Challenges with Tech Help Desk

To illustrate how Tech Help Desk sessions uncovered and addressed a diverse set of computing challenges with entrepreneurs, below are three vignettes of Tech Help Desk sessions which the first author conducted. While each entrepreneur had vastly different technical needs, each vignette showcases how the strategic and responsive Tech Help Desk model uniquely addressed diverse computing challenges.

Non-profit Founder Sets Up to Work from Home During a Global Pandemic

P9 (65-74 year old man, 30+ years running his business), the founder of a local non-profit housing and development association, first heard about Tech Help Desk through the Community Forge monthly newsletter in April 2020.

Initial Computing Challenge. P9 wanted to use TechSoup, a third-party platform that offers subsidized software for non-profits, to download Office 365. His prior Office 365 license was soon to expire and he needed to complete tasks at home on his personal laptop due to the lockdown.

Addressing the Initial Computing Challenge. The provider worked with P9 over the course of three one-hour remote Tech Help Desk sessions to install Office 365 via TechSoup on his laptop. P9 shared his screen so that the provider could provide direct guidance. During moments when P9 would enter sensitive information (username and passwords), the provider would close her laptop partially and communicate she was doing so to P9. The provider searched online for all of the steps required to download the software through TechSoup–this was her first time using TechSoup–and shared the documents she found so they could follow along together. The provider helped P9 formulate a request to TechSoup's customer support to retrieve his license information (which he could not locate in his records). The provider and P9 scheduled a follow-up session depending on P9's preferences. Given the urgency of having this software installed, P9 opted for the follow-up sessions to be within the same week. At the end of the third session, using the latest version of Office 365, P9 successfully opened a new Word document on his laptop.

Addressing Additional and Collaboratively Diagnosed Computing Challenges. P9 reached out to the provider at an additional time in 2020 to set up Constant Contact (to reach his customers during the lockdown). In these follow-up sessions, P9 and the provider spent time sharing how they and their loved ones were doing–at this point, the two had spent several hours together and taking the time to deepen the relationship felt important to both. During these sessions, the provider observed how P9 navigated his file system, retrieved documents, and opened the browser and applications. She suggested ways to make P9's laptop run more efficiently, as well as how P9 could more quickly traverse his file system and find applications. It had not occurred to P9 to attempt to clear disk

space, but instead he had accepted the wait time as applications loaded and closed. P9 set up a total of four additional one-on-one one-hour Tech Help Desk sessions to cover technical issues that arose during prior sessions based on the provider's observations and recommendations.

Between P9's prior experience using TechSoup to download software, and the provider's ability to effectively search for, interpret, and actualize online documentation, together the two were able to address P9's technical requests. The collaborative nature of the sessions increased with each session, as the provider and P9's relationship building deepened.

Returning Citizen Sprints to Finalize Website in time for Marketing Event

P2 (35-44 year old man, less than one year running his business), the founder and sole proprietor of his lifestyle and motivation coaching business, scheduled his first Tech Help Desk session in August of 2021. While in the Community Forge kitchen, the provider ran into P2 and struck up a conversation explaining who she was and what technical services were available to him via Tech Help Desk.

Initial Computing Challenge. P2 shared that he was trying to finish his website (hosted on Wix) in order to have it ready for an upcoming marketing event. Similarly to P9, P2 felt out of the loop with the many computing tools; P2 shared that he had recently completed a decade-long jail sentence and during this time he was unable to stay abreast with the substantial technological advancements. P2 emphasized that he had leaned on the support of his "mentor slash business coach" as well as a close "tech savvy" friend in order to decide which devices to purchase and how to set up his website.

Addressing the Initial Computing Challenge. P2 wanted to update his website's product page, add a video of a recent speech he had given, and finish his blog posts. Even though the P2 had already set up his website with his friend, he could not remember how to

navigate the website's dashboard. The provider loaded his website on her laptop across different browsers and simulated different screen sizes to look for mobile compatibility which he noted in his notebook for future use. The two sat side-by-side viewing each others' screens and the provider created a pretend Wix website on her laptop so that she could familiarize herself with available tools. The initial meeting extended beyond the hours of the Tech Help Desk window, but such flexibility of the provider's schedule was important; P2 expressed needing to be far enough along on any given task where he could continue to work on the task without her assistance.

Between the sessions, the provider summarized the tasks completed in the previous session, the tasks they would collaboratively prioritize in the next session (based P2's preferences), and any action items for P2 to complete between sessions. P2 noted that this documentation was helpful for him to stay on task, as well as visualize the progress he has made. At the end of P2's series of sessions, his online store was up-to-date with all of his merchandise (size and color options), and his website included a motivational blog post and embedded video of his first paid motivational speech.

Addressing Additional and Collaboratively Diagnosed Computing Challenges. P2 began to ask about more types of technical assistance the provider could offer, as he observed how the provider used her laptop to complete similar tasks to his while they sat side-by-side. For example, P2 observed how the provider used keyboard shortcuts and asked *"how did you do that so fast?"* After explaining what keyboard shortcuts were, they reviewed this in the next session (and refreshed these shortcuts every session thereafter). P2 participated in almost 15 sessions as he returned for several weeks, using Tech Help Desk as a concentrated co-working time for technology improvements across his business.

P2 discovered Tech Help Desk through a "water cooler" encounter in the Community Forge kitchen, as compared to the entrepreneurs in the prior and following vignette who were more formally introduced to the service. Over the course of several ses-

sions, P2's resourceful and discerning approach to his business led him to explore the range of possibilities for how Tech Help Desk could help him. Rather than restricting conversation solely to technology, the provider and P2 allocated time for exchanging stories (similar to P9), and P2 often reflected on how his time in jail had impacted his entrepreneurial pursuits. Through these stories, P2 shared he wrote a book while being incarcerated which was stalled due to a few technical complications (which they addressed in follow-up sessions). For both P2 and P9, relationship building alongside technical assistance was important as deepening the relationship helped to extend the technical assistance.

Party Planner Creates a Website in Time for a Bus Ad Launch

P16, the founder and sole proprietor of her three-year-old gift and party planning business, had her first Tech Help Desk session in July 2021. P16 was introduced to Tech Help Desk by a Community Forge director during open hours.

Initial Computing Challenges. P16 wanted help with her website to ensure all was up-to-date in time for her business's ad campaign on public buses in Pittsburgh, PA Tracing information in her inbox as well as her notebook, she explained she had two websites currently registered and did not know how to combine them.

Addressing the Initial Computing Challenge. Together, the provider and P16 discovered that the server P16 was using for one of her websites, donated to her by a friend, was no longer in commission. P16 noted how distressing this period of time was when her website was down: *"I was held hostage at one point with my website. I was so frustrated and it brought tears because that's how I sell my products. And for probably close to three months, my website was down."* Throughout the next four sessions, the provider worked with P16 to curate, refine, and finalize the content to list on her functioning website, implement an intake form for potential customers interested in her event services, as well as update her product listings to include her up-to-date event services. Importantly, P16 often knew the operations required to execute these tasks, but preferred

to sit side-by-side with the provider as she felt more confident to experiment: *"I can sit with [the provider] and click a button and not worry about my whole website crashing." (P16)*. By utilizing Tech Help Desk, P16 felt comfortable to engage in more experimentation with her technical decisions, as she knew someone was next to her in case something went awry. Throughout all the sessions, P16 took detailed notes so that she could refer to them later if she forgot why we made certain decisions or if she needed a refresher for completing similar tasks in the future.

A Reflection on Three Vignettes

All entrepreneurs relied on an ecology of support which they had resourcefully curated to fit their businesses needs across various types of resources (e.g., incubators and courses, friends, peers and informal social support, and hiring temporary assistance). But at some point, each of these types of support had a tipping point where the support was no longer available or would no longer suffice (P2 did not want to strain social relationships with repeated help requests, P16's updated budget disallowed hiring technical assistance, and P9's colleague moved away). Given the strategic and responsive model of technical assistance provided through Tech Help Desk, the provider and entrepreneurs worked together in order to address an array of computing challenges identified by the entrepreneur. Moreover, Tech Help Desk's collaborative approach facilitated relationship building which ultimately led to identifying and solving further computing challenges.

Limitations

Together with our community partners at Community Forge, we co-designed Tech Help Desk within the particular setting of an entrepreneurial hub in Wilkinsburg, PA All entrepreneurs in our study were tenants of Community Forge or participants of the *Business Bloom Program*. This required at least a $100 per month desk fee or an application to the *Business Bloom Program*, thus entrepreneurs needed to have some amount of preexisting capital.

In the future, we aim to make Tech Help Desk accessible to more Wilkinsburg, PA community members beyond Community Forge members, though more work will be needed to facilitate discoverability and scale of the service. While the design of Tech Help Desk may not be fully transferable to new contexts, we encourage future work to explore opportunities to repurpose features of our strategic and responsive model in community-driven projects for entrepreneur technical support. In addition, the research team was predominantly from a private university neighboring Wilkinsburg, PA, and the entrepreneurs at Community Forge were predominantly from Wilkinsburg, PA As shared identity is an important component of trust, Tech Help Desk can work to improve trust by recruiting or hiring providers who have more overlapping dimensions of identity such as place of employment (or status as an entrepreneur), place of origin, or socioeconomic status.

5.5 Discussion: Prioritizing Trust and Relationship Building with Independent Workers

This work uncovered how local entrepreneurs running businesses in a variety of non-technology domains leveraged technology-centered and non-technology centered support to address the technology challenges that they encountered. Through our close partnership with Community Forge leaders and community members, we co-designed a model of technical assistance that is strategic, in that it is designed to fit the context of local entrepreneurs, and responsive, in that it prioritizes emergent needs (See Table 5.1). The two-and-a-half-year (and on-going) deployment of Tech Help Desk demonstrated its support for entrepreneurs addressing computing challenges including troubleshooting support, support for planning and executing a technology project, and support for uncovering opportunities to improve the efficiency of their technology tasks. Our approach enabled us to gain knowledge about the long tail of computing challenges local entrepreneurs with diverse business domains, backgrounds, and goals face (**RQ1**), the ecology of

support resourceful and discerning local entrepreneurs from lean economies construct to overcome technology challenges (**RQ2**), and how a strategic and responsive model of technology assistance can address gaps that standard technical support struggles to remedy within the entrepreneurial context (**RQ3**). Our complementary interviews with individuals who support entrepreneurs as accountants, accelerator managers, business coaches, and lawyers beyond Community Forge provided greater depth to our understanding the importance of Tech Help Desk's uniquely strategic and responsive approach.

In this section, we highlight three key design trade-offs we made to effectively instantiate our model in the context of local entrepreneurs in a co-working space (Table 5.1): (1) responsive rather than standardized support for entrepreneurs solving the long tail of computing challenges, (2) long-term learning rather than short-term problem solving for entrepreneurs balancing technical demands with other business needs, and (3) prioritizing active trust and relationship building.

Responsive rather than standardized support for the long tail of computing challenges

Initial conversations with Community Forge stakeholders highlighted the importance for the research team to provide immediate value for the community upon arrival, so we prioritized responsive technical support through Tech Help Desk's individual support sessions. We identified unique benefits of providing responsive support within the context of an entrepreneur community. First, entrepreneurs who visited Tech Help Desk or participated in interviews described that they used (or planned to use) a variety of other existing services for standardized support such as digital literacy classes or business accelerator programs. In contrast, prior work that provided course or group support for entrepreneurs focused on those who do not have access to these standardized forms of support [140, 227]. Still, entrepreneurs in our study used

the responsive support provided by Tech Help Desk for distinct, time-sensitive computing challenges not clearly addressed elsewhere (e.g., clearing files off of a computer, transferring image files across devices, and removing an image from a Wix website). In the future, responsive support that has access to the dynamically changing needs of local entrepreneurs can inform the curriculum for courses and incubators.

In interviews, participants noted that while existing technology support was offered in courses or incubators, it was primarily oriented towards program goals or a curriculum (similar to tiered curriculum support in education [23, 64, 102, 136]), and thus lacked capacity to support the long tail of computing challenges (See Figure 5.2 for a comparison between curriculum-driven support and need-driven support for local entrepreneurs). Incubator leaders referred entrepreneurs to us for technology support outside of their incubator's scope, and entrepreneurs visited us when other courses ended. In the future, we could also refer entrepreneurs to courses or services as needed. Finally, entrepreneurs leveraged Tech Help Desk's hybrid drop-in and appointment schedule to stop by for a single session (e.g., to clear off files to fix a slow device), or to schedule repeated follow-ups (P2 attended 15 sessions total) to work through a single or emergent set of computing challenges; this scheduling format accommodated varied experience levels.

We also uncovered unique challenges of providing responsive support. First, the novelty of Tech Help Desk's broad and responsive support demonstrated a challenge in communicating its purpose and scope. Entrepreneurs initially approached Tech Help Desk with needs outside scope including making a website for them (providers did not complete tasks for entrepreneurs) or supporting trademark and legal issues (providers did not have legal expertise required). As miscommunication can mean wasted time for busy entrepreneurs, we updated our flyer to describe the side-by-side style and list examples of help we provided (See flyer in Appendix). Second, scaling responsive support to multiple entrepreneurs per provider at a time is challenging. In particular,

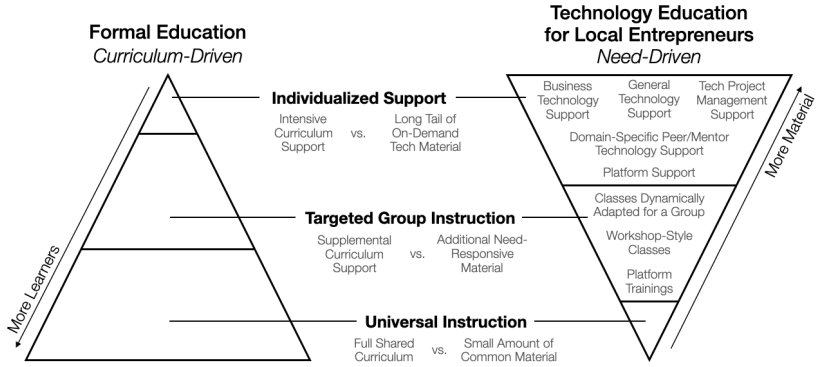

Figure 5.2. A comparison of the traditional Multi-Tiered System of Support [136] for formal curriculum-driven education compared to our model for need-driven technology education for local entrepreneurs.

entrepreneurs' goals and experience levels are diverse, and scaling necessitates less responsiveness to these factors as entrepreneurs would spend less time directly working with the provider. To limit demand, we advertised only within Community Forge (rather than to the surrounding area of Wilkinsburg, PA). In practice, providers worked with one entrepreneur at a time, or two if they arrived at similar times (in which case entrepreneurs occasionally used the opportunity to meet each other). Future work could explore one-to-three (or higher) support by providing a co-working room where the provider can circulate and peers can work together with guidance. Finally, tracking the outcome of highly responsive support like Tech Help Desk is challenging compared to standardized support, where programs may conduct pre- and post-tests for courses or evaluate business success along program goals. Program organizers (P5 and P8) shared that when they facilitate referrals to external resources for technical issues, it is currently either challenging (for website development) or nearly infeasible (for coaching) to manually track and document whether or not the referral was successful. As tracking impact is important for non-profits [40], future work should explore how to deliver and document responsive support to benefit both entrepreneurs and program goals.

Collaborative learning for resourceful and discerning entrepreneurs

Our design of Tech Help Desk involved the resources of a few volunteers to provide an opportunity for support a few hours a week (as opposed to an organization that can provide around-the-clock support [224]). Given that entrepreneurs adapt to changing business needs between and after visits to Tech Help Desk (e.g., adding a product to a website), we opted to promote learning via a side-by-side approach that has been found to be successful for technology learning (e.g., paired programming [117], over-the-shoulder learning [274]).

The design and deployment of the side-by-side approach within Tech Help Desk revealed nuances about the implementation and benefits that differ from prior work. First, providers initially aimed to demystify technological problem solving by expressing when they did not know how to solve the problem at hand and then collaboratively solving the problem along with the entrepreneur. In practice, we found it was also important to establish providers as knowledgeable at the start (e.g., by sharing past experiences and education, knowledge about alternative technology [188, 78]), as entrepreneurs looked for signals to discern that providers would not waste their time by leading them astray. In this way, providers served as both a "guru" in terms of their knowledge, and a "gardener" in terms of fostering a collaborative approach (rather than prior work where employees assumed one role or the other [104]). Second, given the diversity of tools and technology experiences of entrepreneurs, the side-by-side shared screen approach offered the chance to collaboratively discover ways for entrepreneurs to optimize their technology use across a wide range of tasks (e.g., from discovering alternative tools for their work to accessing additional files in a list). In fact, 27 of 61 of the unique computing challenges in our data were collaboratively diagnosed. While independently diagnosed challenges prompted a visit to Tech Help Desk via a notable error or blocker towards business goals (e.g., computer slows to a halt, or not able to update website with new product),

collaboratively diagnosed challenges represented non-blocking improvements for efficiency (e.g., scrolling through files vs. using a work-around) or alternative strategies to using technology (e.g., using a website builder to create a minimum viable web presence rather than building a new web application from scratch). Future researchers and program directors may consider side-by-side technical support as an approach to inform future standardized support or referrals for local entrepreneurs.

The side-by-side approach was not always best for entrepreneurs seeking technology support while proactively managing their time. Entrepreneurs juggling many roles within their company several times visited Tech Help Desk or scheduled an appointment, but selected to not attend or complete the session due to dynamically shifting demands on their time (e.g., an important client phone call or an assistant in need of help during a session). While side-by-side style support allowed entrepreneurs to learn technical skills to maintain any changes made during the session, busy entrepreneurs may benefit from additional opportunities for delegated, rather than learning-centered, support for particularly rare or one-off tasks that are unlikely to require maintenance (e.g., initial device set-up like setting up a printer). Entrepreneurs occasionally identified that they would prefer to delegate a task (e.g., launching a website, designing a logo) to use their time completing a core business product or service that would be more difficult to delegate. This judicious use of time was also encouraged by the business coaches that we interviewed. In this case, our model still can support entrepreneurs – for example, P17 leveraged Tech Help Desk to help identify and assess a professional to hire for her business's website development. Future work may consider how to adapt Tech Help Desk's model for later stages of business where delegation may be more frequently necessary.

Prioritizing trust and relationship building over provider flexibility

When a discerning entrepreneur considers working with a support person, establishing trust – or the belief that engaging with

a person is unlikely to cause harm [103] – is a necessary prerequisite [78]. While help desk providers in traditional workplace settings benefit from institutional credibility when establishing trust [180], our research team was from an institution that historically had a tenuous relationship with community members at our field site [8, 9]. In our study, entrepreneurs also noted they felt their lack of technological expertise made them vulnerable to being disrespected, overcharged or otherwise scammed. To engage in support relationships with entrepreneurs despite prior institutional and technology-related harms, we prioritized actively building trust with Community Forge entrepreneurs.

We identified several strategies for building trust to facilitate technical support in an existing community and space for entrepreneurs. First, the design and deployment of Tech Help Desk benefited from a cascade of trust. That is, we initially established trust with community leaders by dramatically changing our research agenda in response to existing needs of the community space (such change often occurs when appropriately weighing community input above researcher input during community-based research [188]). Building trust with community leaders and providing a community-driven service prompted to Community Forge leaders to then refer entrepreneurs to us; and, these referrals in turn facilitated trust between the entrepreneur and Tech Help Desk provider. Second, entrepreneurs who used Tech Help Desk and Community Forge leaders reflecting on attributes of Tech Help Desk that facilitated trust cited the reliable and long-term nature of technical support. The reliable time and place enabled ease of referral and getting to know Community Forge members when lulls occurred. Finally, the reliability also encouraged entrepreneurs to use their own technical skills more. For example, P16 described how she felt she could now change her website without fear of breaking it for a long time, as she could always visit Tech Help Desk the next Wednesday if needed.

However, it is difficult to tell when Tech Help Desk did not succeed at building trust. When entrepreneurs did not approach

Tech Help Desk or return for a follow up (which happened on three occasions), it is unclear as to why that happened and whether a lack of trust was at play. For example, entrepreneurs may have no longer needed technical help because they addressed the issue quickly, or hired a technical employee (as was the case with one entrepreneur we worked with). However, it is also likely that in some ways we failed to build trust. In the future, we will experiment with alternative approaches to understand the reasons entrepreneurs did not use or continue to use Tech Help Desk services (e.g., by asking collaborating community leaders to talk to entrepreneurs for potentially more frank responses). Finally, prioritizing consistency and relationship building made it challenging to introduce new providers to the project (a months- to years-long rather than drop-in volunteer activity). Future work may explore new incentives for long-term technical support volunteers such as course credit.

In summary, today's local entrepreneurs must navigate an increasing array of technological tools to achieve their business goals. To understand and address the computing challenges faced by local entrepreneurs in a lean economy, we co-designed an on-going technical service, called Tech Help Desk, with a local entrepreneurial hub–Community Forge–in Wilkinsburg, PA Our participatory approach revealed how entrepreneurs resourcefully and discerningly addressed their day-to-day computing challenges by curating an ecology of support, yet many challenges went unaddressed. To keep pace with local entrepreneurs and ever-changing technological advancements, Tech Help Desk mirrored the strategic and responsive approach entrepreneurs took to building their businesses in order to address their long tail of computing challenges. Our work informs researchers' understanding of computing challenges and helps to create responsive technical support within an already existing ecosystem for entrepreneurs.

5.6 Conclusion

Tech Help Desk mitigated additional precarities of independent work by adapting to entrepreneurs' need for temporal and spatial flexibility and by prioritizing trust and relationship building between community members and researchers [188]. Taking a participatory approach which de-emphasized technological innovation was critical as the local entrepreneurs we worked with had already concocted resourceful strategies for addressing their technical needs, and they used a large array of computing tools for business tasks (adding yet another system was counterintuitive). Moreover, a participatory action protocol ensured the collaboration provided immediate value for community stakeholders, and was not extractive in nature. This was particularly important given the tenuous precedent Carnegie Mellon University had set through poor relationship building with Pittsburgh residents, even into present day [8]. Alongside my work with Community Forge, I explored a collaboration with another community partner: a feminist makerspace in Oakland, PA which primarily focused on equity in technology and entrepreneurship.

6 Co-Designing a Peer Support System with Independent Workers

6.1 Overview

In this chapter, I followed a co-design protocol with a local feminist makerspace, Prototype PGH [14], to investigate a peer support system for creative entrepreneurs who made physical goods or offered creative services. Building on Prototype PGH's ethos that everything is a prototype and feedback is critical to success, we began a co-design process through a series of design workshops with 26 local entrepreneurs which investigated the benefits and challenges of feedback exchange among entrepreneurs [171]. Then, we integrated findings from the workshop within an initial software prototype, and proceeded to co-design a mobile application, Peerdea, throughout a three-year collaboration with Prototype PGH [177]. Throughout 2020-2022, Peerdea was embedded in Prototype PGH's annual incubator with 30 entrepreneurs where we continuously integrated entrepreneurs' requests into Peerdea's design.[1]

6.2 Introduction

Creative entrepreneurship—individuals with commercial intention who are engaged in open-ended work [87, 206]—is a source of transformative change in society, creating new avenues for people to engage in personally meaningful work [65], leading to new products and services, new models of business, and positive societal impact, making it an important focus for designing tools to

[1] The published versions of this work can be found in [171] and [177].

support the future of work. Creative entrepreneurship covers a broad spectrum of individuals engaged in creative making work across domains such as design, arts, and media, attempting to commercialize their products and services. This includes creators with diverse backgrounds, engaged in endeavors as diverse as selling personalized, hand-made goods on online marketplaces or providing local services or recreational experiences. For many people, creative entrepreneurship can be a pathway out of dead-end jobs [232], or unemployment [142].

Success in creative entrepreneurship, like other entrepreneurial endeavours, is strongly linked to access to social resources. Access to mentorship can provide entrepreneurs with advice, feedback, and expanded network relations that can promote entrepreneurial skill and self-efficacy development [260]. Access to trusted networks provides the social support and capital necessary for exploration and risk-taking [129, 146], inherent to the entrepreneurial process by enhancing the discovery of information and ideas, connecting entrepreneurs to needed resources, and helping entrepreneurs identify relevant opportunities [129, 130, 255].

In this chapter, I investigated the critical role of makerspaces as sites to support entrepreneurial network building and peer support. Makerspaces have assumed special importance as enabling environments that can provide some of the social resources essential for entrepreneurial success such as forming trusted relations with other members of the makerspace and integrate them into their networks [144, 201]. Though makerspaces—envisioned as spaces that embody the democratizing and empowering potential of "making" [197]—have received criticism for failing to foster the radical inclusion they aim to achieve [197], several makerspaces have demonstrated the ability to create supportive and empowering environments, and elicit participation from marginalized groups [99, 201, 202, 223, 242].

While much research on makerspaces focuses on the in-person interactions within the physical confines of the makerspace, recent work has studied the socio-technical environment within

a makerspace—composed of its community, place-based interactions, and technology-mediated interactions [144, 201]. Social technologies can be a valuable supplement to physical participation by providing more opportunities for interaction with other members, especially when it is challenging to meet in-person. However, most makerspaces that use social technologies adopt publicly available social technologies that were initially intended for enterprise use (e.g., Slack, WhatsApp); none of these are explicitly designed with for the context of local entrepreneur networks. Little work has investigated how social technologies might be designed to most effectively complement in-person interactions. Therefore, it is not clear what an optimal configuration of technological mediation might be within a makerspace.

In this chapter, I detail a collaboration with a feminist makerspace committed to equity in Pittsburgh, PA called Prototype PGH [14], which grew into a co-design process for a technological supplement to the makerspace's annual incubator. We started with a design workshop series with 26 entrepreneurs on how social technologies amplify and stall their efforts to ideate, iterate, and collaborate–all three of which were central to Prototype's ethos that "everything is a prototype" and iteration is critical for success. Building on core findings from this workshop series, we created an initial prototype for a mobile application which structured peer feedback exchange and encouraged sharing early-stage concepts to foster iteration. Then, Prototype leadership, entrepreneurs, and research team all embarked on co-design process throughout three annual incubators with 30 entrepreneurs, where this initial system prototype was continuously iterated on, and evolved into something more than just feedback exchange: general information exchange, peer emotional support and encouragement, and goal setting and accountability buddies. In the remainder of this chapter, I first provide a brief overview of the design workshops series (detailed in [171]), and then I discuss the remainder of the co-design process for a technological accompaniment which was embedded in Prototype's annual incubator, where the goal of the

tool would be to support cohort relationship building (peer support) alongside in-person interaction.

A Brief Look at Social Technologies for Creative Entrepreneurs

To support network building, creative entrepreneurs often use a suite of social systems–technologies that allow people to connect and exchange information with each other. In supporting creative entrepreneurs, these social technologies enable entrepreneurs to develop relationships that are often exclusively virtual, with distributed individuals that can supply previously inaccessible social resources. Creators often publicly share their work in online forums and communities with shared interests, to obtain feedback on their work [51, 58, 178, 292]. They might join online special-interest groups to learn new skills [207, 282], share best practices [207], develop professional status and reputation [207], get feedback [58, 111, 198, 293], find mentorship and help [51, 91, 139, 144], or even to raise funds [27, 146].

These predominantly-virtual relationships that develop from participation in online spaces are often deficient in trust, reciprocity and shared context, limiting the kinds of support they can provide [200]. In a work context, developing trust in an online setting can often be more difficult than face-to-face [41, 153, 289]. Specific to entrepreneurs, the lack of trust in virtual communities can prevent them from seeking feedback and help due to fear of judgement or worse, intellectual property theft [171]. When considering diversity of participation in entrepreneurship, such issues of trust, credibility, and access of social technologies are essential to consider. For entrepreneurs from lean economies, who may not have had opportunity, support, or time to acquire the needed technical knowledge to use social technologies with ease, such technologies may be unappealing, inaccessible, or even dangerous to use [22, 78, 83, 142]. For instance, Avle et al. discussed how, for entrepreneurs in two cities in the Global North and Global South (Detroit, Michigan and Accra, Ghana), an additional set of

tasks were required of them in order to be able to use digital entrepreneurship tools such as discovery and repair [22]. Instead, entrepreneurs in their study preferred leveraging in-person networks of individuals whom were known and trusted. Such trust was especially important because, as Hui et al. discussed, entrepreneurs from lean economies are often pursuing entrepreneurship not out of choice but out of necessity, and trust was required to ensure no loss of livelihood through scams, intellectual property theft and more [142]. Taken together, Avle et al. urged scholars interested in entrepreneurship in lean economies to push past tendencies to take "an outside approach and immediately designed for the most conspicuous issue". Instead, they encourage studying existing forms of support for workers when considering technological interventions [22], to spend time building relationships with community members with tacit knowledge of supporting workers [188], and to leverage design processes which better account for power dynamics between researchers and workers by including workers as equal stakeholders throughout [120]. In this chapter, I take up these calls and build a partnership with a community center dedicated to equity in entrepreneurship, and ultimately this relationship supports a process of co-design for a peer support tool for local entrepreneurs.

Communities of Practice as Theoretical Framework for Incubator Peer Support

To provide a theoretical framework to understand the value of peer support within the feminist makerspace, Prototype, we referred to theories of communities of practice [285]. Communities of practice are groups of people who share context given overlapping interests or concerns and ultimately want to improve their knowledge of this interest. To cultivate communities of practice and facilitate situated learning requires frequent interaction among practitioners which often take place in person in order to support legitimate peripheral participation [186], or an informal process of observation, completing tasks, and learning vocabulary which transforms

novices to expert community members. Through this lens, there are certain aspects of peer support which are relevant such as: sharing strategies for how to complete work effectively, providing apprenticeship opportunities for newcomers to build relevant skill sets, learning needed vocabularies and tacit expertise, and creating norms and routines which ultimately shape the communities of practice, and ensuring that interactions are not solely social. The emphasis on in-person interactions within communities of practice was critical for our collaboration, as it required us to stay grounded within the physical space, to consider what aspects of the interactions among peers could take place in-person, rather than framing the technological intervention as the most central or important space for peer support.

In Schwen and Hara's reflection across four case studies implementing technological mediation in communities of practice or attempting to build new communities of practice online, the authors discussed critical missteps designers often take [251]. For instance, they found that designers tended to overemphasize the role technology mediation should play within the communities of practice, and that the strongest communities of practice used collaborative technologies the least as to encourage other forms of relationship building offline. Even when the technological mediation was expensive, sophisticated, or elaborate, they found no successful creation of an online community of practice. Instead, they argued that the most successful communities of practice were those that deprioritized the role technology played in mediating members' interactions (but note, they did not altogether reject the role technology within communities of practice, and nor do others familiar with the topic). In considering Wenger and Lave's original work which articulated the theory of communities of practice [285], Schwen and Hara highlighted that there was no articulation of what the role of technology was in communities of practice. (Note: Wenger and Lave did briefly discuss communities of practice which evolved around working with emergent technologies [285, Page 119]). Ultimately, they argued that, when considering the role

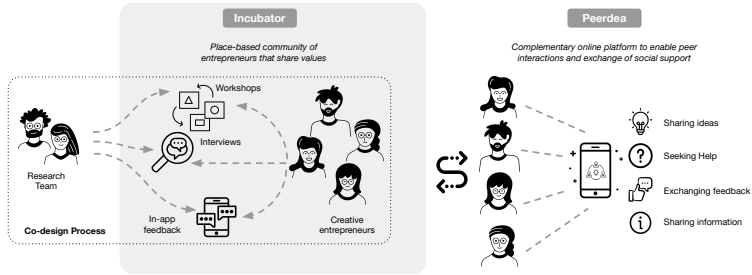

Figure 6.1. This chapter's methodological approach included a series of design workshops with entrepreneurs and co-designing a technological supplements for Prototype's annual incubator.

of technology in communities of practice, "participatory decision making is the only ethical stance possible in this social theory context" [251], because the community's intention was central to goal setting and evaluation.

6.3 Method

In this section, I first discuss my community partnership with Prototype PGH and then I detail our methodological approach starting with a series of design workshops with entrepreneurs to ultimately co-designing a technological supplements for Prototype's annual incubator (See figure 6.1).

Community Partner: Prototype PGH

Founded in 2016, Prototype PGH's mission is to build gender and racial equity in tech and entrepreneurship by "providing affordable access to high tech tools and equipment, offering workshops that prioritize the experiences of marginalized communities, and cultivating a professional support network" [14]. The makerspace is located Pittsburgh's Oakland neighborhood. The space hosts co-working, setups, makerspace equipment such as a laser cutter, 3D printer, and vinyl cutter, and workshops such as body affirming tailoring and salary negotiation. Prototype PGH serves as a hub for local entrepreneurs, through informal meetups and the annual

Table 6.1. 41 creative entrepreneurs participated in design workshops or annual incubator; several entrepreneurs participated in both design workshops and incubator. Note: all names have been changed to pseudonyms.

Pseudonym	Pronouns	Business Domain	Age
Mildred	She/they	Herbal Healing Products	25-34
Shirley	She/they	Technology Bootcamp for Women	25-34
Cayenne	She/her	Inclusive Children's Toys	55-64
Alex	She/her	Creative Writing	35-44
Laurie	She/her	Recycling	25-34
Elizabeth	She/her	Digital Art & Home	18-24
Megan	She/her	Graphic Design & Clothing	18-24
Lilly	She/her	Poetry Publishing	35-44
Erica	She/her	Equitable Machine Shop	18-24
Katie	She/her	Printing Press & Home	25-34
Aliyah	She/her	Inclusive Bath & Beauty	25-34
Amelia	She/her	Massage Therapy	35-44
Clara	She/her	Local Coffee Roasting	35-44
Talia	She/her	Home& Garden	25-34
Zyra	She/her	Clothing & Recycling	18-24
Sam	He/him	Mixed Media Art	25-34
Carly	She/her	Podcasting	25-34
Kim	She/her	Home & Living	35-44
Emily	She/her	Jewelry & Accessories	35-44
Jessie	She/her	Clothing	35-44
Mia	She/her	Jewelry; Home & Living; Production	25-34
Heather	She/her	Fiber Arts	35-44
Sarah	She/her	Pet Supplies	35-44
Aleaha	She/her	Jewelry; Home & Living;	25-34
Lilac	She/her	Clothing	55-64
Riya	She/her	Art & Collectibles	25-34
Miranda	She/her	Art & Collectibles	25-34
Tricia	She/her	Clothing; Theatre Production	25-34
Kristen	She/her	Makeup & Skincare	35-44
Lisa	She/her	Food & Drink	45-54
Haley	They/them	Theatre Production & Education	25-34
Mary	She/her	Art & Collectibles	45-54
Andrea	She/they	Filmmaking & Media Production	25-34
Cindy	She/her	Home & living; Food & Drink	45-54
Tia	She/they	Spoken Word & Poetry	25-34
Eileen	She/her	Educator	35-44
Sierra	She/her	Jewelry & Accessories; Bath & Beauty	35-44
Lola	She/her	Jewelry & Accessories; Clothing	25-34
Beth	She/her	Bath & Beauty	25-34
Natalie	She/her	Jewelry & Accessories; Clothing	25-34
Trevor	He/him	Glass Art	25-34
Jessica	She/her	Bags & Purses	35-44
Richard	He/him	Arts & Collectibles	25-34

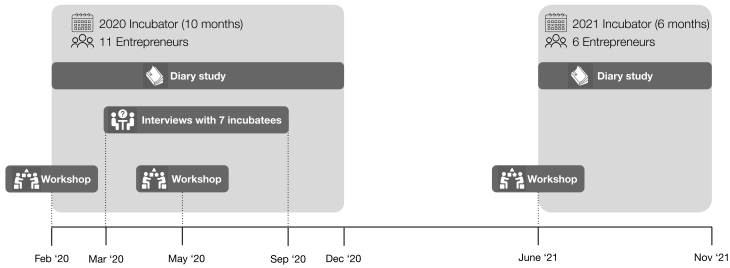

Figure 6.2. After the design workshop series, the first deployment of Peerdea was during Spring 2020 in Prototype's annual incubator. Iterations continued for two years thereafter throughout Prototype's annual incubators.

incubator program for women and people with marginalized gender identities. Since its founding in 2016, the makerspace's team members have spent years building strong relationships with local entrepreneurs. The makerspace's ethos, that "everything is a prototype" showcased the importance of iteration for entrepreneurial and creative success (which we build on throughout the co-design process). Before beginning our collaboration, I was a member of Prototype PGH for almost two years (attending functions and workshops) and I was a due-paying member starting in February 2019 in which I utilized the space's co-working hours and mingled with members in a casual setting. This relationship helped establish rapport with its community members, as well as offered an opportunity to better understand the culture of the space—one dedicated to dismantling systems of discrimination within traditional sites of tech and engineering.

In the following sections, I describe the three part series which ultimately formed the overall co-design process for a technological supplement for peer support, embedded in Prototype's annual incubator, which can be viewed in Figure 6.2.

6.4 Part I: Design Workshop Series

To begin, in the fall of 2019 we hosted a design workshop series and conducted a set of interviews with creative entrepreneurs hosted at

Prototype, focused on understanding how creative entrepreneurs shared ideas, sought feedback, and iterated on their products or services. In these workshops, entrepreneurs shared with us how they used mobile-friendly digital tools and social media platforms such as Instagram or TikTok and messaging platforms such as WhatsApp or Facebook Messenger to create and coordinate networks of peer entrepreneurs, in order to share ideas, get feedback and provide overall encouragement. For example, entrepreneurs organized small, exclusive peer groups on these platforms (e.g., private direct message channels with less than 25 entrepreneurs) and these groups were used to combat the day-to-day isolation creative sole proprietors experience, to share ideas and tips, ask for feedback on designs, customer service issues, marketing materials, and to provide social encouragement.

These small peer groups responded to the expectations entrepreneurs felt to share their content widely and publicly, and instead provided a counter-space to foster small scale exchanges with trusted individuals. Importantly, there was a shared context of entrepreneurial pursuits, and often these groups comprised known peers (as compared to simply acquaintances or unknown entrepreneurs). This facilitated trust which was important to ensure both intellectual property protection as well as a sense of psychological safety. Finally, for the on-the-go, mobile-engaged entrepreneurs in our workshop series, these small peer groups were available via smartphone applications and the asynchronous nature of communication was important as entrepreneurs' schedules varied heavily. These core findings from the workshop series, which were detailed in [171], informed the initial software prototype (Part II) and continuously iterated on through three year-long incubators at Prototype (Part III).

Figure 6.3. A photo from the design workshop series where creative entrepreneurs discussed the challenges of receiving peer support throughout their design process.

6.5 Part II: Initial Software Prototype for Annual Incubator

After the design workshop series, conducting a thematic analysis and writing the results, we conducted a member check with Prototype PGH leadership and a small subset of the entrepreneurs who partook in the workshops (member checks are a technique to test the validity of results through informant feedback [56]). Then, we built on emergent themes from the workshop findings in order to inform the design of a software prototype. We developed a standalone application for two reasons (rather than a plugin or workaround on an existing social tool). First, building a tool from scratch would make it less likely that developers would be limited with what we could alter on the application, and therefore more

accommodating to entrepreneurs requests. Second, many of the systems which entrepreneurs' currently used to exchange feedback (which we could build on top of or alongside of these existing systems [113]) did not address the reputation concerns entrepreneurs' in our workshop repeatedly discussed. That is, existing systems often encouraged entrepreneurs' to share their work publicly and to audiences of large scale (high "broadcast levels" [226]) in order to encourage commitment and boost network value [179]. However, entrepreneurs were concerned about reputational damage that could incur when sharing in-progress or unpolished work online to unknown audiences. Therefore, we focused our attention on creating a space where entrepreneurs could seek early-stage feedback with the goal of mitigating reputational concerns by curating private, small groups of known peers. In this section, I first discuss this initial feature set and how we communicated malleability of the prototype to entrepreneurs to encourage critical feedback to continuously iterate. I conclude this section with a brief note on how we manage requests with alongside constraints such as developer time limits.

In its first implementation, the application–called Peerdea to signify the importance of "Peer"s and early-stage "Idea"s–core features focused on a subset of findings from the workshops focused on supporting feedback exchange among peers. There were five screens within the application: creating a user profile with a profile picture, username and short bio (to facilitate relationship building), joining and/or creating a small group of at most 25 people (incubator cohorts included, on average, eight entrepreneurs, but mentors could also join) with a unique group name and password (all entrepreneurs who partook in Prototype's incubator joined a private group called "Prototype2020", "Prototype2021", or "Prototype2022"), uploading concepts (e.g., photos and videos with a description of least 10 characters) to the group's private feed to ask for feedback (such as early-stage ideas which were pre-market), providing feedback on the concepts shared within a group by completing two sentence starters (e.g., "I like..." and "I wish..." to

encourage both positive and critical feedback [77, 221, 292]). In addition, entrepreneurs were able to view at all times the members of their group as well as their own profile. On their profile (which was visible only to group members), entrepreneurs could update their profile picture and bio, as well as delete any of the concepts they shared across all their groups (in the case they were a member of multiple groups). Given that our original design workshop series included both Android and iOS users, we made sure our development architecture choices enabled an application which supported both smartphone operating systems (rather than developing just for Android, or just for iOS).

By creating an initial prototype, we were able to provide a probe for entrepreneurs to consider how they may interact with their peers in the incubator in an online environment, alongside in-person workshops and co-working. However, the inevitable downside is that we could have prematurely constrained the design space for peer support within the incubator. Ultimately we mitigated this with the following: (1) ensuring the software prototype was based heavily on the design workshop findings (2) conducting members checks to validate or contest data interpretation, (3) ensuring the prototype was minimally designed to present as a skeleton template which needed to be molders–by entrepreneurs, (4) working quickly to implement entrepreneurs' requests and push changes, and (5) all the while ensuring that the tool was aligned with Prototype PGH's overall ethos and motto. I briefly describe these below.

The original set of features and the user interface of Peerdea were kept to a bare minimum in the first implementation to further emphasize the application's infancy, and the need for entrepreneurs using the application to contribute to the design of the application. Research team members and Prototype's leadership repeatedly emphasized during workshops, interviews, and catch-ups that the application was in fact still just a prototype, and the entrepreneurs' expertise was needed in order to make the application the best version it could be. In fact, we emphasized

that the tool was being built collaboratively with Prototype and the researcher team and that the entrepreneurs were more than just "users"; instead they were collaborators (if they would like to be).

When a request was shared with the development team, the development team quickly implemented the request and pushed a new version of the application to TestFlight and the Play Store. This way, entrepreneurs could see that their requests were taken seriously, and implemented as quickly as possible. We set up the application so that we could push changes in real-time. Given the shorter review cycles in TestFlight as opposed to the App store, we kept the application in TestFlight. Similarly for Android devices, the application was deployed as an External Testing which provided shorter review cycles. Simple changes could be made solely on the backend of the application, in which case we could push changes immediately (without requiring an entrepreneur to update their application).

Ultimately, the turnaround time—from request to shipping code—depended on the technical difficulty of the task, and the researchers' bandwidth and therefore ranged before next day to one or two weeks after the suggestions were made. During longer stretches between request and implementation, we provided reminders to participants that we were working on requested changes so that it was clear we were continuing to be actively engaged. Larger requests were implemented between incubators. Making this turnaround salient was important to show users how their judgements influenced the platform directly, thus encouraging and empowering them to continue to provide feedback for how to improve the system.

At the same time, it was important to be realistic with a turnaround time that was feasible for our small development team. Time limitations was one challenge, but also technical feasibility posed additional challenges. For instance, some requests would have required the development team (often just myself and one undergraduate student) to invest large amounts of time to acquire

the skills needed to implement such as creating virtual "walk-throughs" of a brick and mortar store similar to Google's Street View. Therefore, when communicating with entrepreneurs and Prototype leadership about our intention to collaborate and following through with quick turnaround times, we also had to let entrepreneurs know that sometimes a request might take longer to implement in the case that it coincided with midterms or finals.

After creating the initial software prototype of Peerdea, we worked with Prototype PGH leadership to consider how we might implement Peerdea into the upcoming annual incubator, which focused on supporting underrepresented entrepreneurs such as women.

6.6 Part III: Continuous Iteration on System Through Multi-Year Deployment

To implement Peerdea alongside the annual incubator, we worked with Prototype leadership to consider the various approaches we could take. Ultimately, we decided to introduce Peerdea through an in-person workshop towards the beginning of the year-long incubator. Introducing Peerdea at the beginning of the incubator we thought would provide entrepreneurs with ample time to get comfortable with the application and provide feedback. Entrepreneurs were compensated at a rate of $20 per hour for their time spent in Peerdea workshops or conducting one on one interviews. In addition to introducing Peerdea, all entrepreneurs were given journals in the initial workshop which could be used however they thought was best. We provided prompts in the journal to help generate initial entries such as: "What types of products or services have you asked for feedback on yet in your Peerdea group?", "What types of feedback did you receive on your concepts from your peers?", "How do feel about your relationships with your peers in the incubator?", and so on. In the remainder of this section, I detailed the feedback that entrepreneurs provided during the workshops and interviews (which did move online due to the COVID-19 pandemic

shut downs starting in March of 2020).

To start, one concern that came up immediately was the rigidity of the feedback prompts. To leave feedback on a peer's shared concept, entrepreneurs completed the following sentence starters "I like..." and "I wish...". For instance, Mildred[2], who focused on making herbal healing products, shared at the second workshop (which was held three months after the initial introductory workshops):

> "The one thing that I felt was a little difficult was leaving comments, being forced into the 'what do I like?', 'What do I think could be different?' We're all such different companies. Sometimes I feel like I don't know how to give what 'I wish' since I'm not necessarily familiar with certain products or industries."

Since the entrepreneurs in the incubator were pursuing different business domains, some like Mildred did not feel comfortable to provide critical feedback given their lack of domain expertise. In these cases, Mildred wanted to be able to ask clarifying questions, or provide encouraging sentiments. Therefore we adjusted the prompts to provide more options for sentence starters such as "One question I have is..." and to reduce the system's rigidity if a user preferred not to use a sentence starter at all (i.e., they could toggle the sentence starters on and off).

Shirley, whose business was a technology bootcamp for women, commented on this change to make feedback giving more open-ended, and they particularly pointed out how it happened quickly after the feedback was given:

> "I think I noticed that change that you guys did to make it more of an open response as a result, right? There's more open-endedness to it. I think that actually was interesting to see that change can happen in no time."

Such remarks about the co-design process, and timeliness of implementations, were critical to inform the development teams'

[2]Names were changed to pseudonyms to protect the identity of participants.

understanding of whether their communication approaches were in fact working.

Cayenne, who made inclusive children's toys, requested that Peerdea would send her a notification whenever she received feedback, or whenever someone posted to her group asking for feedback: *"But the one thing that I would love to see, I need a notification that somebody uploaded something...A prompt to actually go in and look. Because when I get off of work, I don't even want to be on my phone, computer or anything. So I need some sort of prompt."* While we initially did not want to add to the mounting notifications a mobile user is faced with daily, we implemented a notification feature both when someone commented on a post and when someone posted needing feedback. In addition to the introduction of notifications on Peerdea, we also encouraged entrepreneurs like Cayenne–who did not want to spend additional time on their phones–that they could use the journal we provided to capture their design process, and share this paper-and-pen version with incubator participants during in-person meetups.

There were several other features that Peerdea implemented based on feedback from incubator participants. For example, incubator participants communicated that they wanted to encourage accountability for identifying goals, making progress toward them, and eventually reaching them. In response to this feedback, we implemented a goal setting feature which asked the entrepreneur for their six-month goal (half-way through the incubator) which they could update as needed. In addition, developers implemented another feature when someone who joined the incubator and the small group on Peerdea had to be removed from the incubator and by extension the Peerdea group. We therefore introduced group moderation features, where group administrators could delete users in a group, and then those users were unable to rejoin the group.

Another request from entrepreneurs was in response to Peerdea's emphasis on visuals. For instance, in order to share a concept to get feedback, Peerdea required entrepreneurs to upload a photo or a

video alongside a description of that video. The original motivation for this design decision was in response to a design workshop finding where entrepreneurs discussed difficulties showcasing their creative process. But, as Eileen, an owner of a makerspace said, *"I didn't always know how to translate questions into photos."* In this case, while Eileen was in the process of creating, she had a question she wanted to ask the group which would ultimately inform her design. This desire was especially pertinent among entrepreneurs who provided services as opposed to physical products. For instance, Alex, who had a creative writing business, shared: textit"I don't know if there are visuals, but I think Peerdea is very visual, but maybe I can create a survey or something that will show here's some services I'm thinking about offering. Which of these seems most interesting to you? Or rank them. Something like that." Laurie, who had a recycling plastics business, riffed off of Alex's idea and went on to provide a specific example of how such a survey feature would be helpful for her business:

> "We started collecting plastic once a week on Thursdays, nobody comes, [so] do we change it to twice a week? A different day or different place?"

Even though the pool was small for such a survey (only those in the incubator), Laurie thought she could test out a survey on incubator members and then ultimately send out a larger-scale survey via email and social media. Alex similarly provided an example for her creative writing business and how a survey feature could be helpful. She was attempting to figure out which writing services she should bundle together to offer as a package for customers:

> "Should I start with this package? Or should I start with this [package]? I might just type something and then, you know, do a screenshot of 'Here are the packages I'm thinking about. What are your questions or reservations?' "

Some entrepreneurs hoped to use Peerdea as a place to ask questions and exchange information with their peers and so, they de-

sired media that would support a wider range of information-seeking requests. Mildred further riffed during one of the group workshops, building on a prior suggestion by Laurie:

> "Laurie had mentioned wanting more of a text based [post] as a way to post on the group so that people could, before we have an image ready, say, 'This is what I'm thinking, what are people's thoughts about this taking this next step?' "

Katie, an owner of a printing press business, followed up to share how simple information seeking support may be helpful:

> "Should [company name] start doing more workshops or should we start doing more custom letterpress? How did you make a UPS account?"

Since Prototype PGH's incubator was open to both service and product-based businesses, Peerdea's design needed to be updated to de-emphasize the role of visualizations on the platform. In addition, given these different modalities, some of the entrepreneurs' early-stage artifacts were solely text-based notes of ideas (for an upcoming service they would like to offer, See 6.6). Therefore, we removed the requirement to upload a photo when sharing a concept. To accommodate this broad range of information seeking behaviors, we updated the app so that entrepreneurs could make text-only posts, without visual content. Additionally, we enabled embedding of links within posts so that entrepreneurs could share useful resources with each other. Finally, we also provided users with the ability to author and conduct polls with other groups members so that they could gauge their peers' opinions.

Finally, Laurie reflected on the lagged responses that entrepreneurs had for her posts. As a more active user on Peerdea, she wanted to understand how to boost the activity level within her group. One idea she had was to create another group on Peerdea which she was the administrator of, and therefore she could invite more people. Laurie shared: *"Having Peerdea is helpful, but I wish*

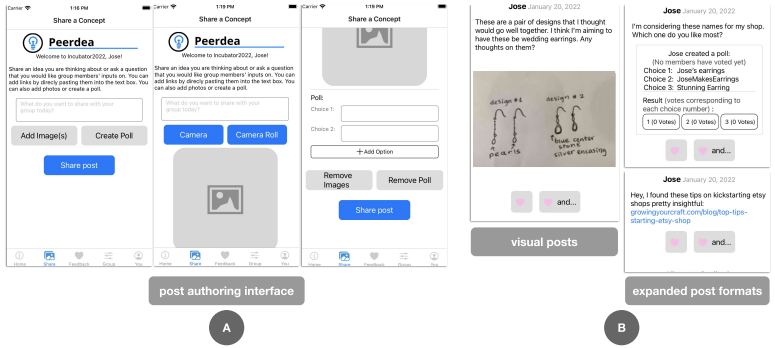

Figure 6.4. Based on entrepreneurs' requests, Peerdea provided support beyond feedback seeking such as general Q&A, sharing links, and photos. Screenshots (A) highlight the authoring interface and Screenshots (B) highlight alternative kinds of requests entrepreneurs could make within their small peer group.

there were more people in our group so that like other people could provide feedback on things." To address Laurie's request, we built out group invitations so that it was easy to invite people to a new group that Laurie created, and simultaneously encouraged entrepreneurs like Laurie to create their own groups within the platform comprised of individuals outside of the incubator (See 6.5).

Taken together, much of the entrepreneurs' feedback circled around (1) loosening the structure that Peerdea initially imposed, as well as (2) implementing entirely new features to support various kinds of information seeking. However, some entrepreneurs felt the structure was helpful, and ultimately this is why we preserved the structure while making it optional. For instance, Shirley emphasized during a group workshop:

> "I think having some restrictions is really good. So it was interesting to be like, well, I don't have anything that I can be like 'Look at this and tell me what you think of it.' So it was like, 'how could I frame it for people so that they could respond to on any capacity."

Here Shirley reflected on the forcing function to have an image to showcase within a shared concept actually encouraged them to

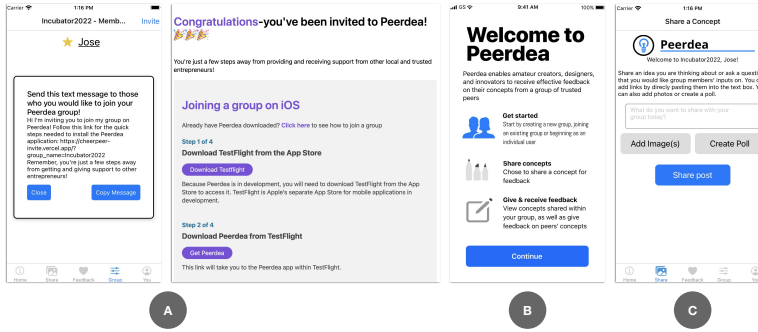

Figure 6.5. If entrepreneurs desired to create their own groups, they did so by (A) Copying and sharing an automatically generated text message which included an invite link. Those who received this message were prompted to follow step-by-step guidance, which was automatically tailored to whether they have an Android or an iPhone. (B) When they joined the group they were onboarded with a walk-through sequence which set norms around sharing concepts and providing feedback, and were then prompted to (C) Share a concept within their Peerdea group.

take their ideation one step further. Ultimately, Shirley appreciated this concretization of their idea.

6.7 Findings

Peerdea was designed as a standalone social technology as opposed to an integration within existing social technologies used by entrepreneurs. One emergent finding which supported this design decision was the entrepreneurs found they were more comfortable to ask for feedback and support from peers within Peerdea (as opposed to on social media for instance) because Peerdea's was an exclusive space meant for this type of interaction. For instance, Peerdea's interface, branding, and onboarding pipeline both in-person and in-app were designed to clearly communicate its intent— that it was an exclusive space for entrepreneurs to exchange support with trusted peers. Megan, a graphic design artist, reflected on how having a distinct platform for support exchange, separated from their other online spaces, can promote experimentation while minimizing potential for reputational damage: *"I'm the sort of person who's very overly conscientious about intruding on*

Figure 6.6. Two entrepreneurs' requests for feedback on Peerdea from within the Prototype incubator; on their new business logo (left) and on an inclusive tech proposal (right). Names blurred to protect identity.

people's space or like asking them for favors that maybe they don't want to give me feedback or maybe they don't feel comfortable giving honest feedback. And they'll just tell me what I want to hear." For Megan, it was critical that everyone within the group had made the explicit goal to provide each other with feedback and support and that this was not an inconvenience to ask for given the intention. Further, Lilly, a owner of a poetry journal, discussed how the intention set by using Peerdea was that of giving and receiving feedback, and how this clarity of intention was critical:

> "I know that anybody that's on that platform is already specifically willing to give and receive feedback."

This intention was communicated through the design of the app itself as well as in the design of invitations to the app. And underscored when onboarding users via workshops. As an environment with an explicit intention of support exchange, entrepreneurs began to view Peerdea as a place they could turn to whenever they needed help.

Moreover, by having a differentiated platform helped to reduce reputational damage that may incur from sharing in-progress or unpolished work. As compared to traditional social media platforms and large online communities, self-presentation goals of entrepreneurs and reputation building can often inhibit help-seeking practices. By creating a space that was disconnected from their customer audience, and included trusted peers, Peerdea provided a space for entrepreneurs to experiment without risking their reputation. Megan discussed how she was able to use Peerdea to get feedback on an idea she was considering that was somewhat different to what she currently offered: putting her graphic design prints on T-shirts, rather than selling them as just prints. Megan did not want to solicit feedback on social media, as she was concerned this would be confusing:

> "I don't want to mess with my [social media] followers' head, but I also want to be able to do something new...So I posted on Peerdea a design idea for a t-shirt and asked if the style that I did going to work well with my current aesthetic. It was really good to just hear a little, honest feedback: 'Yes, there is continuity', because it's so subjective for me."

Ensuring formative feedback is equal parts critical and positive

Peerdea provided light-weight scaffolding to structure feedback exchanges among users. Once we implemented entrepreneurs' requests to relax some of the structure, entrepreneurs discussed together we co-designed a was the sweet spot of structured support. Entrepreneurs reflected on the fine balance they observed Peerdea to take between providing enough support within a feedback exchange to know how to proceed, but not too much structure that would be overly cumbersome to busy entrepreneurs. To begin, Erica, who ran a machine-shop focused on equity in making, noted the importance of how Peerdea aimed *"to train people in this lan-*

guage of constructive feedback giving and asking." Similarly, Shirley reflected on how Peerdea helped to inform their creative process: *"I think [Peerdea] really pushed me to start thinking about things differently and create a solution where we had the problem [and] we didn't know what we were doing."* Alex specifically reflected on the importance of ensuring positive feedback among entrepreneurs: *"It [asking for feedback on Peerdea] was very kind, and it wasn't even a shredding process. People were like, 'Wow, this is really intriguing! I want to know more. This is where I'm confused.' "* Here, Alex reflected on prior experiences asking for feedback, where she felt as if she was being torn down or "shredded" with negative remarks. Alex continued on to share how the equal parts of critical and positive feedback she received on Peerdea allowed her to more easily digest the critical remarks: *"So these are the gaps I need to fill in which isn't anything to be [ashamed of]."* In the next section, I detail the importance of leveraging small groups of known peers when scaffolding formative feedback among creative entrepreneurs.

Small groups and membership controls to reinforce communal underpinnings of support exchange

The social architecture of Peerdea's groups reflected practices and preferences of entrepreneurs in designing effective spaces for exchanging support that preserve (1) trust, (2) reciprocity and (3) shared context. Below I provide a brief summary of how entrepreneurs experienced each of these dimensions of Peerdea's resulting design, as well as provide a overview of Peerdea usage data. Then in the following section, I describe how Peerdea failed to deliver on each of the three design dimensions. Finally, I conclude by resituating Peerdea's final design within the context of communities of practice.

Trust: While users can create any number of groups, joining a group required them to know its name and secret "pass-phrase", only communicated through an invite. Peerdea did not show a list of available groups or their contents, restricting visibility to only those who have been invited to participate in a group. In this way,

Peerdea favored groups of individuals that know each other offline as opposed to groups convened online-first, as with the group of entrepreneurs united through participation in Prototype's incubator. Peerdea did not attempt to manufacture trusting relationships among users, but rather tap into existing structures of trust, acknowledging the critical need for trustworthiness in interactions (livelihoods on the line), and software's difficulty building adequate trust online. Entrepreneurs did not want to receive feedback from troves of anonymous crowds, as Lilly described:

> "I think it's a lot easier to take feedback positive and negative from people that you know, and trust."

Peerdea groups consolidated trust through transparency within a group. When users joined a group, they can see information about all existing members of the group such as their profile pictures, member-written bios, and posts shared previously. In this way Peerdea limits visibility of group actions and content outside the group, while aiming for transparency within. By uniting existing trusted contacts, Peerdea allowed users to engage in open, honest, and authentic communication. Elizabeth, who made digital art and homewares, reflected on asking her close friend who was also an entrepreneur. She shared:

> "I feel like we're pretty good at, if we have some an issue or something, we're good at communicating about it. So we have a foundation of good, open, honest communication. In relation to feedback, it just kind of felt safe to like give each other feedback when asked."

Megan, Elizabeth's good friend, in response shared:

> "It takes times to build relationships necessary for critical feedback. She was like, 'I don't want to hurt your feelings or anything.' I feel like we've gotten to a point where we're pretty comfortable telling each other what we think...I mean, years and years of friendship, I think

> this is the main thing and just all the rapport that comes with that"

Reciprocity: To cultivate supportive communities, members should feel motivated to reciprocate the support they receive. A prominent antecedent of reciprocity is the existence of a "shared identity" [93]. When members of a group feel like they are part of a community and feel close to each other, they are more likely to reciprocate support [93]. Large groups are often unsuccessful at cultivating a "shared identity" by providing fewer opportunities for meaningful interpersonal interactions [240]. In contrast, small groups are more effective at building shared understanding and identity [147]. Again, Maya touched on this point while reflecting on her relationship with Elizabeth, whom she called "Lizzie":

> "[My idea has] been floating around for a long time and having the actual design and having the app available and knowing that Lizzie is there for me to answer questions about it. [Peerdea] just gave me an avenue to ask."

This desire to reciprocate support, in large part due to preexisting or offline relationships, was also reflected in feedback we received from Cayenne as she sought to have more app support around reciprocity: *"One thing that I would love to see, I need a notification that somebody uploaded something because otherwise yeah. And your prompt to like, actually go in and look, because when I get off of work, I don't even want to be on my phone, computer or anything. So I need some sort of prompt."* In this way, Cayenne wanted the Peerdea to prompt her to respond to group members' requests because she often was very busy and was worried she might forget to respond.

Shared Context: Good feedback is contextual [122]. In large online affinity groups on Dribbble and Reddit interactions are often absent of rich shared context, and responses can be off-topic, out of scope, and occasionally, even discouraging [171, 292]. En-

trepreneurs expressed concerns about seeking feedback in such poorly contextualized environments.

> "My concerns with sharing things for feedback is that I want to make sure that people understand what they are looking at. People don't quite understand what the constraints are financially."

In this case, Lilly was concerned that others (even the other entrepreneurs in the incubator) would not understand the business models relevant in poetry published. Ultimately Lilly was concerned that others would suggest ideas for things to do that were out of scope given her limited budget. Peerdea, by emphasizing the creation of small focused communities, promoted the creation of groups with highly specific shared context. The specific context created an environment conducive to exchanging help. Katie, who ended up making her own group on Peerdea, noted that the context she created on the app, by way of curating the group, and that this was helpful when asking for feedback: *"I know what to share based on the group that I've made"*. Shirley echoed Katie's sentiments and shared: *"People kind of understand where they are with that thing and just put it up. So we've been trying to figure out, how can I support you? As somebody who's gone through things like this."*

Peerdea Usage Data

Repeatedly throughout both incubators, the research team alongside Prototype PGH leadership emphasized to the entrepreneurs that Peerdea usage was not our goal. Instead, we discussed how entrepreneurs could use Peerdea how ever they prefer. For some entrepreneurs, this meant exploring other ways to ask for feedback outside of Peerdea with groups of entrepreneurial friends who were not in the incubator (in the case of Eileen and Shirley) or with a basis of loyal customers (in the case of Laurie and Eileen). In addition, we provided entrepreneurs with a journal in the introductory workshop, which we encouraged them to use as a reflection tool as they proceeded throughout the incubator. Therefore, Peerdea

usage data may not hold as much gravitas as system deployments which optimize for data collection (or, perhaps it holds more gravitas as usage was more likely to reflect value added).

How Peerdea Failed to Foster Peer Support and Feedback

While Peerdea's design continued to evolve based on entrepreneurs' requests, it is important to highlight some of ways the original Peerdea design constrained the design space suboptimally for effective peer support among entrepreneurs. Entrepreneurs repeatedly echoed three concerns (1) small groups meant fewer people to provide feedback, and sometimes entrepreneurs wanted a higher quantity of feedback, (2) the shared context of creative entrepreneurship was not always enough, and sometimes entrepreneurs needed feedback particularly from entrepreneurs with shared domain expertise, and (3) the experience of asking for early-stage feedback felt to some like stalling, rather than making forward progress.

First, Peerdea's small groups were based on the average size of the incubator with a cushion for Prototype staff and researchers to also join to provide feedback when activity was low. However, sometimes entrepreneurs wanted more feedback, not only to collect more information but also because the quantity of feedback was seen as an indicator of interest. For instance, Shirley shared: *"I don't think as many people responded as I would've liked."* and Laurie echoed, *"I got a few [comments]. I wish I had gotten more feedback from more people basically, but I understand that that's not gonna happen."* Laurie reflection shared a critical tension: she knew from first hand experience how busy her peers were throughout the incubator, and as a result she realistically noted that more feedback from her peers was perhaps a far reach. However, we can consider other ways to change the composition of a Peerdea group in order to amplify the quantity, and by extension quality [172], of exchanges on Peerdea. For instance, as Prototype PGH continues to explores ways to incorporate more mentorship into the platform, we can consider having mentors join the Peerdea group with the explicit role of providing feedback.

Second, entrepreneurs within a Peerdea group were unified through their pursuits of creative entrepreneurship. However, their entrepreneurial domains were diverse such as body-affirming massage therapy, spoken word performances, poetry publishing, inclusive children's toys, and more 6.1. Sometimes, this lack of shared domain yet shared entrepreneurial pursuits provided an ideal amount of "forest vs. trees". Other times, entrepreneurs needed feedback from someone who had a deep understanding of the particulars of their domain. For instance, when Laurie posted a request for feedback on a flyer for a new plastic collection site, Shirley needed further information before they could feel comfortable to respond: *"I honestly would have liked to see more, in terms of her initial phasing, like 'Where is there a location now? What else can I learn about plastic? What do these numbers mean?' I just don't know that much about plastic, unfortunately."* Shirley's lack of knowledge around plastic type and Pittsburgh's handling of plastic recycling left them in need of further clarification before providing feedback. While Peerdea nudged users to provide a description of any images shared, there are opportunities to consider additional prompting to the solicitor to make explicit certain kinds of information which seem obvious to them (such as Laurie's deep understanding of plastic type). Facing a similar predicament, Alex considered one resolution to help her viewers to provide more accurate and helpful responses, even though none of them were creative writers like herself. Alex, who wanted to solidify the price points for a set of services she was soon to roll out shared: *"I think it's a good [thing] to say 'Other coaches charge this: ___.' I could put that as part of my [post], so people can get a sense of what is out there because people might not know."*

Finally, asking for early-stage feedback is usually associated with addressing potentially serious issues created in further iterations, and ultimately reducing expensive changes down the line [270], Yet, the entrepreneurs shared their experience of asking for early-stage feedback as sometimes feeling like stalling, or a distraction from making forward progress in the business. Part

of this sensation of stalling was due to a desire to get something done as Eileen shared: *"I've been guilty of just like wanting to move ahead and just like pick a thing, even if the thing is wrong. Like even if the direction is wrong, just like move in that direction. So you're not staying static."* Eileen went on to reflect on a conversation she had with Laurie as stated: *Laurie was communicating this idea that if you're asking for feedback too much, then you're not really making progress"*. Ultimately, there seemed to be a fine balance, a sweet spot, of the amount of early-stage feedback one seeks compared to marching along in one's design process in order to neither stall nor go off the rails; In the future, we can explore this sweet spot with entrepreneurs in incubators to come.

How Peerdea extended Prototype PGH's Community of Practice

With Prototype PGH leadership and a set of 43 creative entrepreneurs, together we co-designed a technological supplement for peer support within Prototype's annual incubator which extended Prototype's ethos that iteration is crucial for success. To do so, we relied upon communities of practice as a guiding framework for (1) considering both how Peerdea could contribute to Prototype's existing community of practice and (2) providing guardrails as to not overemphasize the role of technological interventions [138]. I discuss in detail each below.

First, Peerdea embodied certain attributes of Prototype's community of practice. To facilitate norm setting among community members, Peerdea's core functionality was built around the makerspace's ethos, that everything is a prototype and that iteration is crucial for success. Peerdea's core feature set which prompted feedback seeking was accompanied with nudges to ask for feedback earlier on in an entrepreneur's design process, as seeking early stage feedback improves quality of iteration [88]. As sometimes asking for early-stage feedback can be challenging for creative entrepreneurs, especially those without a formal background in the arts [175], Peerdea's loose structure provided scaffolds for both

positive and constructive feedback. Ultimately, these features also fostered entrepreneurs' skill sets around asking for and giving feedback and altogether improving their creative processes. In addition, Prototype repeatedly emphasized the importance of working around the schedules of busy entrepreneurs and accommodating any scheduling conflicts (such as providing childcare as we did during all in-person workshops). Specifically, for busy entrepreneurs it was important that any systems they used be accessible through smartphone devices in order to support their on-the-go business style. Peerdea accomplished this in part by being a mobile application for both iOS and Android users.

In addition to building on theories of communities of practice in considering how Peerdea could contribute to Prototype's existing community of practice, by combining such theories with a co-design methodology, together this provided guardrails to not overemphasize the role of technological interventions. Specifically, leveraging a framework of communities of practice, which are most effective when there are in-person interactions, de-emphasized the role of technology by (1) how to consider the role of a technological supplement to strengthen a community of practice by aligning with Prototype's ethos, (2) what other contributions to the incubator should be prioritized along a technological supplement, and (3) in what ways technological intervention would be disadvantageous, less appropriate, or potentially harmful. I describe each of these three in more detail below.

First, theories of communities of practice provided a framework for how to consider the role of a technological supplement to strengthen a community of practice by aligning with Prototype's ethos, and the importance of a co-design approach alongside. In Schwen and Hara's critical reflection of the role of technology in communities of practice, they argued that the most successful communities of practice were those that deprioritized the role technology played in mediating members' interactions.-=11"[3] They

[3]Yet another thoughtful edit by Scout—as she rolled across my keyboard—which I have preserved in the final draft of my dissertation.

go on to suggest that the only way to successfully incorporate technology into a community of practice is through a co-design approach as this will ensure that community intentions and goals are adequately surfaced. Therefore, we considered in what ways technological interventions for peer support could be integrated as a supplement, rather than the main focus or contribution. The leadership at Prototype PGH discussed how it was hard to translate the ethos of Prototype into action; although their ethos was that "everything is a prototype", they did not necessarily know how to transfer this to those who used their space. While the design studio "crit" is the canonical go-to when fostering an atmosphere which triumphs iteration, this model is costly and time consuming. Instead, a rapidly growing amount of literature focuses on how to support online exchanges which foster similar outcomes to an in-person design crit [96, 184, 269]. Therefore, by building on this body of work and acknowledging its deprioritized role, Peerdea's design supported asynchronous online peer support and feedback exchange, alongside the relationship building among entrepreneurs in-person.

Second, theories of communities of practice alongside a co-design approach provided a framework for how to consider what other contributions to the incubator should be prioritized along a technological supplement. As a co-design approach emphasizes relationship building, mutual trust and respect, and value generation for participants, we prioritized hosting in-person workshops (when possible given the global COVID-19 pandemic) in order to provide opportunities for further relationship building and technological repair [245]. During workshops and interview, the conversations spanned beyond Peerdea, and sometimes researchers provided technological support for entrepreneurs with other aspects such as website building. In addition, we also worked with Prototype leadership to facilitate grant writing, particularly centered around equity in technology and entrepreneurship. I argue that these other activities were critical to our co-design approach such that when difficult topics inevitable arose, such as when Peerdea failed

to provide support, entrepreneurs felt comfortable to share such stark critiques (in contrast to tendencies for users to provide solely positive feedback when engaging directly with developers [270]).

Third, by extending Prototype's existing community of practice alongside a co-design approach, this surfaced in what ways technological intervention would be disadvantageous, less appropriate, or potentially harmful for entrepreneurs. Conversations were sparked around how Peerdea should and should not facilitate certain kinds of interactions among entrepreneurs; trust was not going to be easy to build online and encouraging such behaviors through technological intervention was a mute point. Instead of trying to "go beyond being there" [131], entrepreneurs wanted to be "there" not "beyond". But when they could not be there, Peerdea was able to foster peer support through online and asynchronous peer interactions.

6.8 Conclusion

Prototype PGH provided a physical meeting space for digitally-engaged entrepreneurs to seek a community of practice [285], establish a sense of place, and engaged in situated learning practices such as legitimate peripheral participation [283]; all which are especially important to entrepreneurs engaged in open-ended work. But when schedules picked up as they inevitably did for busy entrepreneurs, or when in-person meetings were otherwise not available, Prototype desired a virtual accompaniment to their makerspace, specifically for entrepreneurs participating in the annual incubator. Because Peerdea leveraged existing relationships and in-person relationship building among users, Peerdea was used as a trustworthy virtual space for digitally-engaged entrepreneurs to ask for advice and feedback, general information exchange, as well provide emotional support.

To mitigate challenges throughout the co-design process due to power differentials we rapidly integrated entrepreneurs' request to showcase system malleability, did not push usage of the system (but instead focused on differing levels of engagement and how

entrepreneurs appropriated the application), and we showed up in-person when permitted for co-working and troubleshooting support. When co-designing Peerdea with 43 creative entrepreneurs in total, entrepreneurs' requested improvements centered around (1) loosening the feedback exchange structure that Peerdea initially imposed by making default settings optional, and (2) implementing entirely new features to support various kinds of information seeking beyond design feedback–such as general Q&A, surveying, and sharing inspiration. Hosting in-person workshops alongside provide opportunities for system maintenance and repair. Taken together, Peerdea and Tech Help Desk required multi-year relationships built on mutual trust and clear expectations. In Part III, I considered directions for future work such as addressing the challenges to sustaining these collaborations and interventions over the long term.

Part III

Conclusion and Future Work

7 Conclusion and Future Work

By drawing on both participatory action research and sociotechnical system design, this dissertation bridged these disparate bodies of work to contribute an approach to developing community-based peer support systems, novel algorithms and interfaces for algorithmic interpretability and novel interaction designs for peer support systems in work. The resulting peer support systems—Hirepeer [159, 174], Peerdea [171, 177] and Tech Help Desk [173]—were both online and offline, extended existing, trusting relationships between workers, and the latter two were driven by the community needs of two partners: a feminist makerspace (Prototype PGH in Oakland, PA [14]) and a co-working and resource center (Community Forge in Wilkinsburg, PA [13]). In addition to these technical contributions, this dissertation contributed educational materials for independent workers' technical skill acquisition, a novel model of on-demand technical support for independent workers, grant writing with community partners, and in-person workshops to provide software maintenance support.

Underpinning these contributions were multi-year collaborations with community partners who displayed long-standing commitment to supporting independent workers. These community partnerships were critical when building peer support systems in light of the tendency for sociotechnical approaches to take an outsiders approach and terminate development after publication [22, 69]. By taking a community-based approach, the peer support systems in this dissertation incorporated community partners' formal and tacit expertise from their day-in and day-out work alongside independent workers. In doing so, this dissertation

addressed three limitations of a sociotechnical approach to peer support: (1) the tendency to overlook existing, offline networks of workers, (2) the expansion of the digital divide among workers with lower levels of technical literacy, and (3) the loss of relational aspects of peer support when optimizing for large-scale, online adoption.

However, as with all approaches, community-based approaches also have their own set of challenges. For instance, one core challenge for community-based approaches relates to *sustaining* community-based approaches, and any resulting interventions, over the long term. Therefore, to conclude, I provide a brief look towards sustaining the relationships and interventions—Peerdea and Tech Help Desk—which resulted from my community-based approach in this dissertation.

7.1 Towards Sustaining Community-Based Research With Independent Workers

One of the most important issues for community-based researchers is the relationship between outside researchers and community members [157]. To be successful, partnerships in community settings must "develop relationships, demonstrate commitments, and overcome personal and institutional barriers" [188]. In doing so, community members often are the drivers of such processes and researchers provide on-demand support at community requests, as they fulfill a facilitating role (as opposed to a directing role common in professionally-led human-centered design [125]).

Yet several tensions exist when ensuring the solutions derived from a community-based approach are sustained over the long term. And at the highest level, the challenges to sustaining community-based research touch upon the larger discourse of sustainability in human-computer interaction research [254]. Within this body of work, questions arise around definitional clarity as there are various ways that researchers with human-computer interaction define "sustainability": from economic sustainability to environmental

sustainability and more [75].

Therefore, future work in community-based approaches to system design can continue to build on this larger discourse of sustainability [84], specifically by providing detailed accounts of the various forms of sustainability (and the related challenges of each form [188]). For instance, one challenge with sustaining the resulting interventions from community-based research—such as Tech Help Desk and Peerdea—is: who decides what sustainability success looks like, and how might success change overtime? As discussed in Chapter 5 "Participatory Action Research with Independent Workers", I reflected on how community members' needs changed in critical ways throughout our multi-year (and on-going) collaboration, and how sustaining the original model of technical support—Tech Help Desk—may not keep pace with the increased demand needed at Community Forge. In this case, one of original ideas I discussed alongside my community partners was to increase the capacity of Tech Help Desk by recruiting more providers from neighboring universities and the local community. However, with shifts in my community partner's objectives, programming, and funding, together we decided to pursue an altogether new way to sustain Tech Help Desk which differed to our original set of ideas. In the end, we co-designed a technical course for local entrepreneurs which aimed to achieve several learning objectives such as reclaiming entrepreneurs' power in technology and equipping entrepreneurs with the language, confidence, and skills to use technology for their business.

The need to adapt interventions to sustain community-based research efforts is also apparent, and perhaps even more challenging, when the intervention is more technical. Because it is hard to rebuild a system from scratch to satisfy evolving needs, efforts which focus specifically on sustaining community-driven technological design tend to prioritize linearity [54]: they mainly consider ways to maintain the initial intervention rather than iterating to respond to the twists and turns of community-based research [188]. As described with Tech Help Desk, it may be the

case that over time an entirely new model, or new software system, may need to be created to satisfy evolving community needs. Tandon et al., for instance, provided a detailed account of maintaining community-driven development of a digital dispatch system with a taxi driver union [264]. The authors described the need for the research team to constantly adapt to the evolving demands of their community-based research project as they provided community partners with various types of support: design, technology, technology assessment, and transportation technology research. Along the way, Tandon et al. provided a detailed account of the various types of hurdles and even hostility as their team proceeded throughout a multi-year collaboration or as they described, "the work to keep the work going" [264]. Therefore, addressing issues of sustainability in community-based work will respond to calls by human-computer interaction scholars to provide detailed accounts of the messy, behind-the-scenes work which is often required in community-based research but which often goes unreported in computer science publication outlets [188]. In Chapter 6, "Co-Designing a Peer Support System with Independent Workers," I reflected on how sustaining Peerdea—a native application—surfaced issues with sustaining sociotechnical interventions over the long term, given that the default approach is often that researchers to retire tools after publishing [254]. In this case, questions around relational integrity between research and community partners are surfaced, especially in the problematic case where researchers have committed to long-term collaborations with communities which then fall short.

Other challenges to sustaining community-based research are more practical in nature such as how academic contributors can be transient: student contributors of such projects are likely to complete their degrees and move elsewhere to continue their careers. In addition, funding for a community-based research projects may run out, leaving no way to provide financial support for the student(s) to engage in the research activities, or fund community collaborators for their participation in the project [264]. While

student tenure and grant expiration are initially practical concerns, they have deeper consequences in their ability to undermine relationship building between institutions.

Taken together, my dissertation work echoes arguments that one of the most important parts of community-based research is the relationship between researchers, community leaders and community members. Ultimately, not following through on commitments to communities can erode higher-level relationships such as those between institutions [188]. Such collaborations may be already teetering on a tenuous relationship between academic and community partners; as in the case of Tech Help Desk where Wilkinsburg residents and Carnegie Mellon University had a long standing relationship of erasure [8]. Specifically in the context of independent work, workers who participate in or use outcomes of community-based research (such as Tech Help Desk and Peerdea) ultimately use these services to support their livelihood. Therefore future work can continue to explore the following research question:

- How can researchers and community partners sustain interventions and relationships derived from community-based research, such as Tech Help Desk or Peerdea, over the long term?

In addition to making strides towards sustaining community-based research, in the next section I briefly discuss several other directions for future work based on my dissertation work.

Additional Research Questions for Future Work

This dissertation highlights several other directions for future work which touch on the following topics: (1) independent workers' need for temporal and spatial flexibility, but not at the cost of heightened uncertainties, and (2) independents workers' drive for community and sense of place while reckoning with the importance of the digitization of labor, and (3) independent workers who may not have physical spaces to foster in-person trust building

and relational peer support, for instance due to their geographic location (e.g. rural environment).

To begin, my dissertation work challenges a larger presumption that flexibility for workers (deciding who to work for, and when and where to work) comes at the cost of heightened uncertainty [230]. To do so, I presented a novel model for on-demand technical support—embodied in Tech Help Desk [173]—which prioritized flexible location and timing to respond to the busy schedules of independent workers. By default, Tech Help Desk provided on-demand, in-person help sessions mid-week in our community partners' co-working space in order to emphasize trust building among workers, and between workers and researchers. Alongside this default, our model of technical support also responded to workers' needs for spatial and temporal flexibility by providing remote sessions (via video conferencing platform) throughout the week. Similarly, Peerdea relied on in-person relationship building between workers while they co-located at the feminist makerspace for co-working and workshop hours [177]. Workers then continued their offline discussions online and asynchronously on Peerdea in order to account for workers' needs for temporal and spatial flexibility.

Across both Tech Help Desk and Peerdea, the emphasis on in-person meetings and trust building mitigated uncertainties involved in independent work, as peer workers and researchers became vetted confidants over time. In a similar vein, Tech Help Desk and Peerdea also aligned with our community partners' primary objective of fostering a local community and sense of belonging among independent workers who by default operate in isolation [141]. Future work can further explore these tensions between designing for temporal and spatial flexibility and relational peer support, the need for digitization of work alongside the drive for community and sense of belonging, and finally, fostering in-person congregation and coalition building among independent workers who do not have such spaces by default.

As such, relevant questions for future work to explore may include:

- How can human-computer interaction scholars collaborate with independent workers' to continue uphold their need for temporal and spatial flexibility, but not at the cost of heightened uncertainty?

- How can human-computer interaction scholars and community partners reckon with the realities of digital meditation of work and fast pace change while acknowledging the gravitational pull for community and sense of belonging?

- How can human-computer interaction research support independent workers who do not have formal physical spaces dedicated to their enrichment such as local entrepreneurs do in metropolitan environments (e.g., makerspaces and incubators)?

Taken together it is my goal that, in grappling with these questions, human-computer interaction researchers can work alongside community partners in order to co-design a more inclusive future of work.

7.2 Limitations

There are three core limitations of this dissertation. First, while peers are united through a shared context, life experience, or expertise, peers may not always be supportive. For instance, peer workers can been seen as in competition with one another and thus workers' intellectual property or reputational concerns may be heightened when working with certain peers (e.g., bringing together micro-entrepreneurs who have similar businesses and are pursuing similar markets locally may be counterproductive) [171]. One way I addressed this limitation with my community partners was to unite workers who had at least slightly different domains, or who were pursuing different markets.

A second limitation of this dissertation is that not all independent workers seek local community support. For instance, Qadri and Raval's ethnographic work in the Global South detailed the "single fighter" phenomenon where some independent workers preferred to work in isolation from others in their local community [10]. This was in part because of how certain community settings were unfriendly towards certain workers, based on systemic biases embedded in that community (e.g., women workers preferred to avoid with men workers' "brotherhood" networks and sexist tendencies). One way I addressed this limitation was to work with community partners who had clear mission statements detailing the importance of equity and intersectionality among independent workers [70].

A third limitation of my dissertation work reflects the limited physical infrastructure for independent workers in the United States today. Across the United States, there exist few kinds of community spaces relative to the range of independent worker types such as online freelancers, on-demand care workers, delivery drivers, and so on. While there are exceptions—such as one popular online labor platform's attempt to create co-working spaces for their online freelancer [5]—these spaces tend to be costly and exist in large and affluent cities. In Pittsburgh, there exists several entrepreneurial co-working and incubator spaces to support entrepreneurs at all stages and sizes, but few community-led groups for other kinds of independent workers. Therefore, the community partnerships in my dissertation reflected this local context and my community partnerships focused on mainly independent workers who were micro-entrepreneurs. Future work may consider community-based approaches to peer support systems with other kinds of independent workers such as on-demand care workers who may be more likely to create informal coalitions to address their needs for peer support.

7.3 Conclusion

This dissertation contributed an approach to developing community-based peer support systems to overcome limitations of a solely sociotechnical approach to building peer support systems. To do so, I bridged participatory action and system design through multi-year engagements with local community partners. The resulting peer support systems—Hirepeer, Tech Help Desk, Peerdea—were both online and offline, extended existing, trusting relationships between workers, and were driven by the community needs of two partners: a feminist makerspace (Prototype PGH in Oakland, PA) and a co-working and resource center (Community Forge in Wilkinsburg, PA).

Along the way, this dissertation contributed novel algorithms and interfaces for algorithmic interpretability and novel interface designs which highlight unique considerations for peer support system design when embedded within a work context. In addition to these technological contributions, this dissertation contributed educational materials for workers' technical skill acquisition, a novel model of on-demand technical support for independent workers, grant writing with community partners, and in-person workshops which complemented peer support systems to provide supplemental support. Underpinning these contributions were multi-year community collaborations and studies which illuminated workers' socio-emotional, technological, and material challenges when engaging in digitally-mediated independent work.

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A Supplemental Materials

Semi-Structured Interview Protocol with Tech Help Desk Participants and Other Community Forge Business Owners (60 min)

Introduction

- Establish Zoom connection, work out any technical issues
- Thank you for participating!
- Brief introduction of interviewer
- In this study, we're hoping to learn how entrepreneurs use technology (e.g., phones, laptops, printers, software like Excel, social media like Instagram) to achieve their business goals, and what barriers they encounter when trying to use technology as part of starting their business. Today, I'll ask a couple background questions about your business and what technology you use. Then, I'll ask about any problems you have encountered with technology, and if/how you have solved those problems. Finally, I'll ask you about what resources you wish were provided for entrepreneurs trying to use technology to meet business goals.
- The interview today will last 60 and you will be compensated with $20 at the end of the interview. You can stop the interview at any time and you'll receive compensation for the part of the interview you completed.

- Do you have any questions for me before we get started?
- Is it OK if I start recording this interview? [If yes, start recording. If no, terminate interview]

Background Information

- Describe your business(es) in a few sentences.
- Are you the sole owner/operator of your business(es)? Do you have additional people employed or helping? (e.g., an assistant, a friend, an employee)

Resources

- What types of technology do you use for your business?
  - Hardware (e.g., phone, laptop, desktop computer, printer, fax machine)
  - Social Media (e.g., Facebook, Instagram)
  - Websites & Software (e.g., Wix, Squarespace, Excel, Word, Quickbooks)
  - Cloud services (e.g., Google Drive, Dropbox)
- Have you sought external help as part of starting your business?
  - Physical resources (e.g., space, machines, materials)?
  - Financial resources (e.g., investments, grants)?
  - Educational resources (e.g., courses, workshops, online trainings, one-on-one help)?
  - Emotional resources?

Technical challenges in starting a small business

- Have you encountered technical challenges in creating a small business? Was there a time when you were not able to

overcome a technical issue? Please tell me about it, and how you felt.

  - For example, challenges related to:
  - Tools: e.g., Hardware, Social media, Websites & Software, Cloud services?
  - Services & Contracting: e.g., hiring someone to build an app or website, calling a printer company to fix your hardware
  - Balancing professional and professional personal technology use (work/life balance) e.g., shared business and personal phone, personal vs. business online presence

- How do these technical challenges impact your ability to reach your business goals?
- When you managed to use tech successfully how did that impact your business goals? If you managed to get through or avoid a challenge what resources did you draw on?
- How interested are you in acquiring the technical skills relevant to running a small business?
- How do you balance the technical demands of being an entrepreneur with the many other tasks you must complete?
- When you think about the technical demands of being an entrepreneur (setting up & maintaining website/social media/business management software/email/etc), how does this make you feel?

How do you find solutions to technical challenges that you encounter?

- Do you feel there are enough existing resources for entrepreneurs to overcome technical challenges?
- What additional resources can you imagine being helpful?

- Prompts for solutions (follow up to challenge questions): Did you find a solution to your technical challenge?

  Yes
  - What was the solution?
  - How did you find it?
  - Did you try other things before you found the solution?
  - How long did it take you to find a solution?

  No
  - What were the barriers to finding technical solutions? (e.g., time, cost, did not trust the options, did not know where to start, did not know who to ask, feel like you need more knowledge or formal training, don't want to ask one person too many times)

- Have you visited Tech Help Desk?
  - What was the challenge that brought you to visit Tech Help Desk?
  - Did Tech Help Desk help you find a solution to your problem?
  - What is one suggestion you have for how we may improve THD?

Closing

- That's the end of our interview! What questions do you have for me?
- Thank you so much for sharing your experiences as an entrepreneur.
- Closing; Stop recording; Handle payment

Semi-Structured Interview Protocol Interview Protocol for External Participants and Entrepreneurial Providers (60 min)

Introduction and Consent

- Establish Zoom connection, work out any technical difficulties
- Brief introduction of interviewer
- Consent procedure
- If participant consents, begin recording. If not, terminate interview.

Background

- Describe the organization you work for in a few sentences and its relationship to entrepreneurs
- What is your role within the organization?
- Can you walk me through your day at work yesterday? How was it different or similar to a 'typical day'?

Overview of resources and services

- What kinds of businesses or organizations are they forming when they seek out your organization? (e.g., products, services, non-profits, local vs. online) – Prompt for examples.
- How do entrepreneurs find out about your organization? (e.g., word of mouth, other partner organizations, formal advertisement)
- What are the formats that entrepreneurs engage with your organization? (e.g., a single visit to an office, a phone consultation, a multi-day workshop) – Prompt for specific examples.

- What resources does the organization provide to help entrepreneurs? – Prompt for specific examples of how entrepreneurs have used resources.
  - Physical resources (e.g., space, machines, materials)?
  - Financial resources (e.g., investments, grants)?
  - Educational resources (e.g., courses, workshops, online trainings, one-on-one help)?
  - Emotional resources? (e.g., a support group or club for entrepreneurs, a friend or family member to talk through solutions)

Technology challenges when creating a small business

- From your experience, what are a few of the technological barriers that entrepreneurs face when they are starting a small business?
  - Types of challenges:
    * Troubleshooting existing technology (e.g., the printer breaks)
    * Not knowing what technology to use (e.g., know they want to create a website but do not know where to start)
    * Needing to use technology with a high learning curve (e.g., want to use Salesforce but do not know how to use it)
  - Types of technology:
    * Hardware (e.g., printers, fabrication machines, fax machines, laptops, keyboards)
    * Software (e.g., accounting, project management)
    * Cloud services (e.g., Google Drive, Dropbox
- How did you learn about these types of technology challenges?

- Are there patterns that you see in the ways people solve their technology challenges?
  - Does your organization have formal or informal resources internally to help people solve technology challenges? (if so, what?)
    * If the organization provides technical help, what are the prerequisites that equip people to serve in this role?
  - Does your organization refer people to other organizations to help solve technology challenges? (if so, where?)
- Are there any patterns that you see in the road blocks people run into when trying to solve their technology challenges?
- Can you walk me through a success story of a business working through their technical challenges?

Tech Help Desk Feedback/Reflection

- We have been implementing a Tech Help Desk at Community Forge what challenges do you see with this approach to providing technical assistance? What benefits do you see with this approach?
- Tech Help Desk provides one instance of how a university can provide technical assistance to local entrepreneurs – what other ways could you imagine a university provides this assistance?

Solutions

- Are there any services or technologies you wish the entrepreneurs in your organization had access to (either inside or outside of the organization)?

Closing

- Are there any questions you have for me?
- Closing; Stop recording; Handle payment

Tech Help Desk Informational Pamphlet

Figure A.1. Tech Help Desk Pamphlet, Page 1 of 6

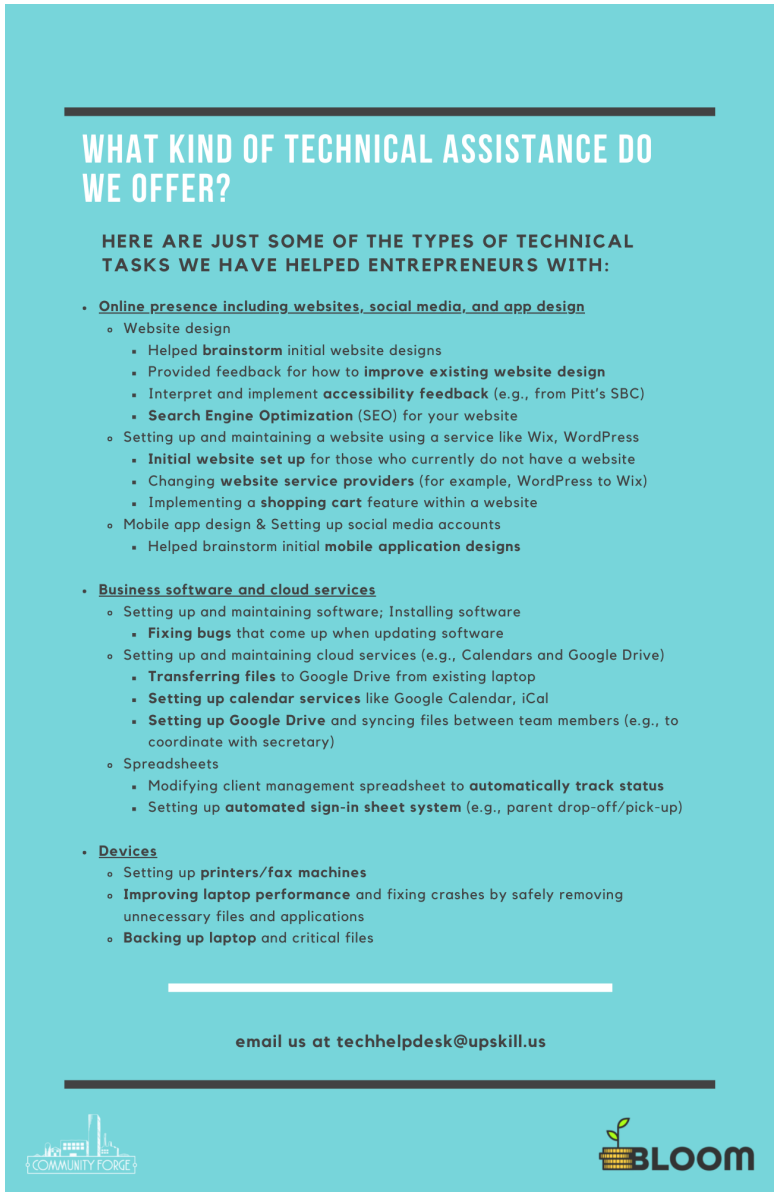

Figure A.2. Tech Help Desk Pamphlet, Page 2 of 6

Figure A.3. Tech Help Desk Pamphlet, Page 3 of 6

Figure A.4. Tech Help Desk Pamphlet, Page 4 of 6

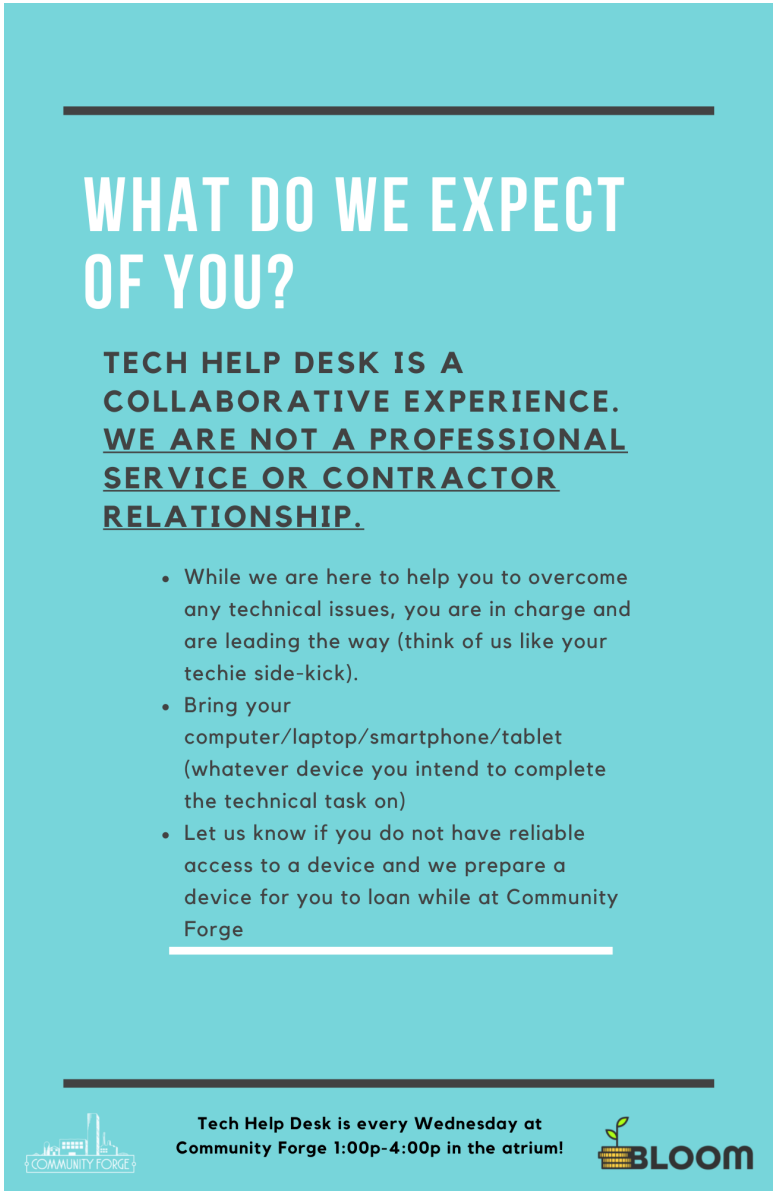

Figure A.5. Tech Help Desk Pamphlet, Page 5 of 6

Figure A.6. Tech Help Desk Pamphlet, Page 6 of 6