Understanding the Homepreneurship Opportunities Afforded by Social Networking and Personal Fabrication Technologies

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The decreased cost and increased usability of personal fabrication technologies has enabled a new generation of crafters to integrate digital designs and computationally created artifacts into physically-based practices. With the simultaneous ubiquity of e-commerce and social networking channels, these technologies have enabled many crafters to transform their hobbies into home-based businesses. To understand the opportunities and challenges that fusing social networking platforms, personal fabrication equipment, and e-commerce have afforded these homepreneurs, an online survey and follow-up interviews were conducted with crafters who use hobbyist cutting plotters to personalize and sell goods online. The findings uncovered an emerging group of homepreneurs, i.e., mompreneurs, who use these technologies for supplemental income for their families and highlighted the emotional and opportunistic benefits that such personalized, at-home manufacturing affords. They also highlighted the workflows and lifestyle implications of using these technologies to run home-based businesses, the multi-faceted usage and dependence these homepreneurs have on online social platforms such as Facebook, the complex software toolchains that are used, and the commonplace practice of appropriating designs from others that occurs in this community.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI) • Applied computing → Electronic commerce → Online shopping • Applied computing → Physical sciences and engineering → Engineering → Computer-aided design**

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1 INTRODUCTION

Personal fabrication technologies have become ever more ubiquitous in recent years. Due in part to the expiration of technology patents and growing enthusiasm for making and DIY practices, novices can easily gain access to, and work with, personal fabrication equipment such as laser cutters, 3D printers, CNC routers, and cutting plotters.

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Because these technologies have software that abstracts away the programming of the hardware itself, they support untrained users in creating high quality, professional looking artifacts quickly, without the need for hours of practice or apprenticeships with manual tools or techniques [61, 67]. Simultaneously, there has also been a growing population of users who utilize personal fabrication technologies at home for entrepreneurial purposes within the digital economy. These homepreneurs design, manufacture, and distribute goods by themselves or with the help of their spouse or children [105] and sell these goods online via Etsy, Amazon Handmade, or personal websites. For example, homepreneurs have used 3D printers to manufacture Mickey Mouse headbands [4] and cookie cutters [127], and laser cutters to make biologically-inspired wooden puzzles [104] and personalized wooden cutting boards [29]. Recently, a growing community of crafters has begun using cutting plotters, i.e., low-cost, desktop-based personal fabrication machines, to design, make, and sell personalized goods. Cutting plotters have become increasingly popular entrepreneurial tools because they are inexpensive and have a shallow learning curve: users can download pre-made designs from an online store, use auto-adjusting blades and pre-defined cut settings to cut designs out of paper, plastic, felt, or films purchased at local craft stores, and quickly apply these designs to "blank" goods such as coffee mugs or apparel.

Unlike other crafters who make and sell goods online via e-commerce platforms and 3rd party brokers such as Etsy, Shopify, or Amazon Handmade [60, 76, 85, 90], crafters who have integrated desktop cutting plotters into their workflows leverage unbrokered e-commerce models that are built on personal social networks and local social networking groups to advertise and sell goods. Because social networking channels do not support the listing of goods, order tracking, or payment processing, these homepreneurs have developed ad-hoc strategies and processes such as paper-based analog order tracking forms and personal email tagging systems to compensate for this missing e-commerce functionality. This work explores the activities and practices of this community of crafters turned entrepreneurs because, unlike the examination of more general DIY activities [4], this lens allows for a focused view of homepreneurship within the context of an emerging type of personal fabrication machine [24, 36, 52] who's usage patterns and challenges have remained unexplored within the literature. These machines were also chosen over more classical personal fabrication equipment such as laser cutters, CNC routers, or 3D printers because they offer much more flexibility in terms of safety and expense (i.e., they can be used within a home and their materials are inexpensive), physical footprints (i.e., they do not require a dedicated room and are quiet so they can be used at all hours of the day), and they offer increased personalization opportunities and high levels of throughput.

The practices of this crafting community thus provide a unique lens to understand the opportunities that the fusion of personal fabrication technologies and social networking platforms have afforded homepreneurs. Online survey data from 49 Canadian homepreneurs and semi-structed interview data from 9 of these homepreneurs revealed that many individuals in this community identify as women and a unique subset (i.e., 69%) are 'mompreneurs' [26, 39, 47, 115], i.e., "*women who discover and exploit new business opportunities within a social and geographical context that seek to integrate the demands of motherhood and business*" [39]. The data also uncovered the ubiquity of social networking channels to connect with clients and sell goods, the organizational strategies homepreneurs use across social networking channels, and the challenges inherent in protecting their own, and appropriating others', intellectual property. These homepreneurs were also found to be similar to sharing economy or gig workers in that

they hold many of the same motivations for participating in the digital economy such as economic, empathetic, and altruistic desires, in addition to value-based incentives like self-improvement or therapeutic fulfillment [10, 16, 77]. They differed, however, in that these homepreneurs were found to have complete control over the environments that they work in and clients they take on, they do not rely on obfuscated, match-making algorithms to assign tasks or orders to them, they set their own prices and pricing models, and they perform long-term emotional labor to maintain personal relationships with their clients [35, 63, 75, 99, 124].

By surveying and interviewing this community of homepreneurs, this work contributes (i) an analysis the opportunities this emerging personal fabrication technology has afforded to a new generation of homepreneurs, (ii) the identification and exploration of the personalization-based workflows and lifestyle complications that arise when these personal fabrication technologies are used at home, (iii) a discussion of the implications that platforms such as Facebook have when they act as a scaffold to the digital economy, (iv) the challenges that arise when one's online business and personal identities are fused, and (iv) examples and possible solutions to the troublesome intellectual property appropriation and technical obstacles that arise when using social media to sell goods locally.

2 RELATED WORK

This work is inspired by, and builds upon, prior research on the gig economy, social networking usage by homepreneurs, the augmentation of craft processes using technology, and the entrepreneurial opportunities afforded by personal fabrication technologies.

2.1 The Gig Economy

The last decade has seen a substantial increase in the number of individuals taking part in the gig or sharing economy through platforms such as Uber, Lyft, TaskRabbit, Upwork, and so on. As identified and reviewed by Dillahunt et al. [35] and Sutherland and Jarrahi [125], much research has focused on understanding the working conditions of gig workers [1, 15, 66], the costs and benefits of gig economies to society [19, 80, 113], the factors motivating workers [10, 19, 16, 77, 111], the manners in which trust is built within these communities [2, 3, 35, 50], and the socio-technical implications of using social economy platforms [50, 68, 69, 71, 74, 80], among others. Of most relevance to the present exploration is research into worker motivations and the affordances that social economy platforms provide.

Many researchers have focused on understanding the benefits and motivations that encourage participation in the gig economy. Some research, such as that conducted by Buda and Lehota [22], Szymkowiak and Zelichowska [126], and Hamari, Sjoklint, and Ukkonen [57] has focused on understanding why consumers participate in these economies, finding factors such as increased experiences, sociality, economic benefits, and sustainability crucial to participation. Aside from shared economic benefits, these motivations differ from those who work within these economies. For example, work by Broughton and colleagues, which interviewed 150 gig economy workers in the UK, highlighted the important role of flexibility, particularly with respect to those with care commitments, demands from studies or school, or desires for autonomy [19]. They also found that many gig workers viewed the gig economy as the "future of work", a way to gain work experience when initially starting in the work force or transitioning between full-time jobs, and as a stigma-free type of work that supported those with mental or physical disabilities. Many others have

identified that for those who participate in online piecework platforms [81], Chinese Didi taxi-drivers [99], Uber drivers in Canada [111], and Etsy shop owners [76], perceived flexibility and autonomy are crucial to participation. Others have uncovered more intrinsic and socially-based motivations such as the desire to be intellectually stimulated and feel competent or validated, enjoyment from connecting with clients, the ability to express one's creativity, and relatedness and feelings of being "needed", but noted that there can be tensions between these and more instrumental (i.e., economic) needs [65, 76, 116]. In a review of such motivations, Bellotti et al. proposed an eight category classification system that integrates Maslow's hierarchy of needs [16], i.e., empathic/altruistic, instrumental, intrinsic/autotelic, safety, social influence, social connection, status/power, and value/morality. This classification is used within the present work to examine why homepreneurs participate in digital economy marketplaces.

Research has also identified and explored the many implications that social economy platforms and their inherent task assignment strategies have on gig workers. The most classical methods for gig workers to be assigned or given gigs are through mobile social economy platforms that allow workers to be assigned tasks on-demand, often via obfuscated, unclear algorithms or through an auction or bidding mechanism that enables them to choose jobs or gigs [68, 69, 74]. These techniques are used by companies such as Uber, Lyft, TaskRabbit, Instacart, and so on, allowing for the real-time, decentralized assignment of tasks to workers, while enabling workers to largely maintain their flexibility and anonymity [32, 124]. This method of task allocation has been found to create asymmetries between workers and social economy platforms [69] because platforms themselves take a cut of a worker's profits even though the worker is fulfilling or completing a task, workers have little recourse if they receive a bad review or feedback, and workers are often unaware of the factors that algorithms use to assign tasks or make them available to perform [68, 69, 74, 73, 99]. In addition, the anonymous nature of social economy platforms prevents workers from harnessing their personal social networks to obtain tasks or exert agency over the specifications or characteristics of a task [74, 124]. Although those who sell wares or content using e-commerce platforms such as Etsy, Amazon Handmade, or Udemy may not fit one's classical view of a gig worker, these workers essentially receive "gigs" or orders from a centralized platform that acts as a broker between those offering services (i.e., Etsy storeowner) and those wishing to "hire" or "purchase" these services (i.e., clients). The tasks these workers are "assigned" usually allow for a degree of customization and agency that is greater than that found with more classic gig economy workers, however, many buyers and shop owners are anonymous, making it difficult to build social relationships or emotional connections [33]. However, if a shop owner provides their phone number or links their social media presences to their online stores, then they can build trust between themselves and buyers and cultivate a social community of followers [50, 79]. The homepreneurs surveyed and interviewed within this present work were found to differ from these two communities in that unlike classical gig workers, they did not bid on tasks or have tasks assigned to them via an algorithm and they were able to set their own prices for their services. Unlike those who use e-commerce platforms, these homepreneurs have complete control over the clients they take on, the goods they create, and they often develop personal relationships with their clients due to their use of social networking platforms such as Facebook, local buy-and-sell groups, and text messaging and email to communicate with clients.

2.2 Social Networking for Homepreneurship

The use of social networks and online groups for homepreneurship has long been an area of interest within the research literature, however, the analyses of the use of these platforms have

come to diametric conclusions. Research by Durah, for example, interviewed German mompreneurs' use of online groups and social networking platforms [38]. They found that these platforms were most often used to advertise one's business, but that they also provided encouragement, care, and emotional inspiration, somewhat akin to a support group. Work by Nylander and Rudstrom, which focused more generally on entrepreneurs' use of Facebook groups, forums, and community websites in Sweden [108], found that these networks were used to grow, enhance, and market one's business through fact-finding and networking, rather than as sources of support. The findings from the present exploration muddles this research further by demonstrating that many homepreneurs used these platforms in ways that are similar to Durah's findings, however, they tended not to share or provide support to those they consider to be competition within their local geographic area.

A growing body of research has also focused on the opportunities that engaging, visual social networking platforms have afforded entrepreneurs. AlArfaj and Solaiman, for example, interviewed female homepreneurs in Saudi Arabia and found that Instagram was the most useful platform for selling goods because it could be used as a virtual "shop window" for clients and the ability to link to other social media platforms enabled high levels of engagement and trust [2, 3]. Within China, livestreaming platforms such as Douyin have been appropriated by practitioners of intangible cultural heritage activities to (i) demonstrate ancient cultural practices during a livestream and then sell the resulting artifacts to viewers or (ii) livestream workflows and processes while making commissioned pieces and ask buyers for feedback in-stream [89]. Similarly, Songket weavers in Malay were found to use Facebook to post images of their goods for advertising, however, middlemen and merchants prevented co-design activities between clients and weavers [138, 139]. It is interesting that Saudi Arabian and Chinese entrepreneurs are using social media not only to advertise their goods but also to engage with, and get feedback from, their clients in a very public way, whereas Songket weavers have middlemen do this for them. While many homepreneurs use social media to interact with their clients via Facebook wall posts, few reported that they talked publicly about order requirements, costs, processes, or design decisions with clients. They instead preferred clients to contact them via private Facebook or Instagram messages, email, or text messages.

As recommended by Foroutani, Rahman, and Aedi [43] and Gahan [46], home businesses that use social networking successfully should update their social networks as often as possible, tailor their products and services to the demographics of their social media followers, and engage in after-sales support strategies to maintain client bases. These findings were echoed in work by Hui et al., who found that in resource-constrained communities in Detroit, the building of in-person connections and sales support was still required even when social networking was used to find clients [63]. As shown in the present work, and work by Cesaroni and Consoli [24] and Holmes, McLean, and Green [60], while homepreneurs know that they should perform these activities, they often do not because they lack the time or technical knowledge or have uncertainties about the perceived benefits. The present work additionally shows that homepreneurs are often unsure what content to post to each social media channel, so rather than synthesizing and using the viewership demographics or analytics provided by platforms, they do not post anything at all.

Lastly, within the United States, mothers have used local 'buy-sell-trade' groups on Facebook to trade and buy goods [97]. These groups have intense sales competition between members and use restricted group membership to build and facilitate trust amongst buyers and sellers. The homepreneurs interviewed herein are often members of similar groups and offer their goods and

services within them (referred to as 'buy-and-sell' groups because 'trade' is not common within them in Canada), however, homepreneurs use techniques such as word-of-mouth and client reviews to build trust with clients rather rely on restricted or curated membership lists. These groups were also found to have a secondary purpose, i.e., to learn about competitors' goods and prices so that homepreneurs can remain competitive in local markets.

2.3 Augmenting Craft and Artisanal Processes with Technology

Hybrid crafting [51] has become popular within HCI because it enables crafters and artisans to augment and enrich their physically-based, traditional practices with digital artifacts, processes, or data. Much research on hybrid crafting has focused on the fiber arts. For example, the Stitch Sampler [119] used wearable electronics and conductive fabric to enable sewists and embroiderers to create musical notes whenever their needle entered or exited fabric. With Spyn, knitters could record, playback, and share information and events relating to their hand-knitting activities with others using a mobile phone and infrared markers [117]. Work by Goodman and Rosner explored how knitters and gardeners used various technologies such as digital patterns on tablets, online searches for techniques, or digital photos to document sensory interactions as a means to extend, interject, and segment their practices [54]. The Making Core Memory project [118] and Sew-Flow [64] also explored the fusion of technology augmentation and textile-based crafts via conductive threads and thermochromic materials. Each of these projects has integrated technology into an artisan's workflow to allow for enhanced interactivity throughout one's process (as with the Stitch Sampler) or after the artefact has been completed (as with Spyn, Sew-Flow, Making Core Memory, and Goodman and Rosner's work). This has largely ensured that the artisanal activity itself has remained the same. The present study differs in that it explores how technology (i.e., desktop cutting plotters) has supplanted traditional methods used to create an artifact, (i.e., scissors or a craft knife) rather than enhanced the process or experience of the final artifact itself. This has opened new opportunities for individuals to participate in a practice, community, and marketplace that previously required great time, patience, and skill.

Others have explored how personal fabrication technologies such as 3D printers can augment traditional artisanal processes. With Digital Joinery, for example, carpenters could combine 3D printed, generatively-designed joints with hand-made wood artifacts to create multipart structures that are difficult or impossible to make using only traditional hand tools and techniques [91]. 3D printing has also been used by Nachtigall et al., to enable one to 3D print replacement shoe soles using data that was collected from wearing their shoes [103]. The ONEDAY project extended Nachtigall et al.'s work further by distributing toolkits that contained shoe-making materials that could be manipulated and augmented using personal fabrication technologies such as laser cutters [102]. The present work contrasts this literature by focusing on the personalization of crafts and artifacts not for the maker themselves, but for friends, family, or clients, and with the goal of generating income. These differing motivational and economic foci may explain why interviewees and survey respondents were less concerned with creating new designs and more concerned with appropriating existing designs to achieve greater economic gains.

2.4 Entrepreneurship with Personal Fabrication Technologies

Within the literature, desktop cutting plotters have been used to develop new fabrication methods [31, 87, 88, 110] or forms of artistic expression [7, 121], rather than as lenses to understand entrepreneurship. Personal fabrication technologies such as 3D printers, laser

cutters, and CNC routers, however, have been found to provide a plethora of opportunities and benefits to entrepreneurs. Most importantly, the decreasing costs of these technologies and associated materials have enabled many entrepreneurs to "*scale up from one*", i.e., slowly grow their business without the need for external capital [83, 101]. They also support rapid changes to product designs because they allow for small batch processing and on-demand production, negating the need to carry a large inventory [83, 98]. Small batch processing also allows for short product life cycles and limited editions, artificial demand, and increased sales [83, 114]. As the interview and survey findings will demonstrate, desktop cutting plotters offer homepreneurs these same opportunities: most homepreneurs grow their business out of their own personal finances, they are able to rapidly change their product offerings to meet client, seasonal, and market demands because they produce goods on-demand, and they do not take on large inventories of "blank" materials to reduce costs and capitalize on clients' fears of missing out.

The small scale and digital nature of personal fabrication technologies such as 3D printers, laser cutters, and CNC routers, has also been found to create barriers for entrepreneurs. For example, the use of small batch processing can limit one's ability to plan for the large scale manufacturing of products because entrepreneurs still often perform hand-finishing or final assembly of their artefacts - tasks that cannot be easily automated for large scale manufacturing [84]. Like cutting plotters, these personal fabrication technologies' reliance on open-source formats, editable digital file formats, and online repositories of 3D models or graphics also creates intellectual property challenges [49, 73, 83, 98], however, as this work will show, the plotter *software* required to operate these machines contains functionality that uniquely encourages homepreneurs to utilize other's intellectual property.

Within the larger arenas of making and DIY, there has been increased interest in the entrepreneurial opportunities afforded by the *environments* where personal fabrication technologies are used. Makerspaces offer hands-on experiences amongst like-minded people and offline communication via social networking, thereby enabling makers to learn entrepreneurial skills such as coaching, modelling, and scaffolding [62]. Makers also do not own the equipment in a makerspace so they are more likely to experiment to the point of failure because their "threshold of performance" and the costs of incurring and overcoming failures are lower [96]. Because makerspaces emphasize community-based values such as care and social support, makers commonly feel more comfortable exploring new materials and equipment [130]. As the present survey data revealed, many cutting plotter homepreneurs do not "explore" with new materials and techniques, choosing instead to conduct small scale trial and error cycles to prevent material waste and save money. While homepreneurs do use social networking to connect with their community, the competitive nature of their marketplaces often prevents them from sharing ideas and or helping others, which differs from observations of makerspace culture. Lastly, because homepreneurs fund their own equipment and work at home, they do not have the same opportunities for exploration, learning, and mentorship that are found in makerspaces today.

3 BACKGROUND ON DESKTOP CUTTING PLOTTERS

Desktop cutting plotters are personal fabrication machines that cut graphics out of materials, negating the need to use a craft knife or scissors to do so. They use a removeable swivel-head blade that is mounted on a belt inside the machine and controlled by a stepper motor. Using

plotter-specific software, a user can create or import a 2D vector design (Fig. 1a), place a material to be cut on an adhesive-backed mat and load the mat into a cutting plotter (Fig. 1b), and then select the material to cut using a pre-defined dropdown menu in the plotter software or a physical dial on the plotter. The plotter then auto-adjusts the cutting blade to a pre-specified depth, moves the blade along the x-axis at a pre-specified speed and pressure, and moves the mat and material along the y-axis in and out of the plotter using a series of rollers.

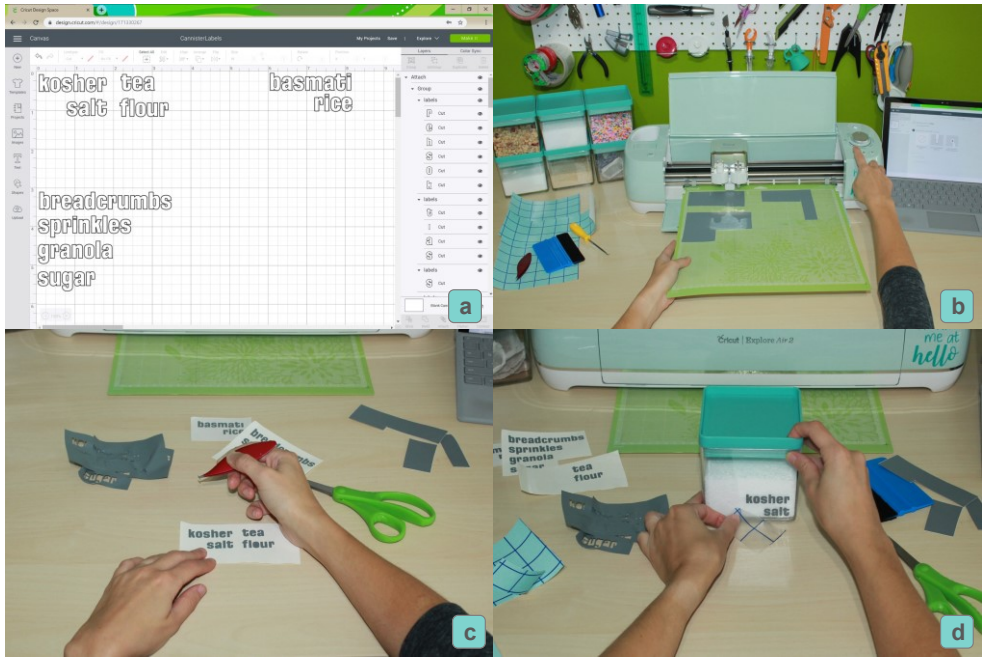

Fig. 1. A demonstration of using a cutting plotter, wherein (a) a user creates a design in the plotting software, (b) they load a mat with their desired material into the plotter, (c) once a design is cut by the plotter the excess material is weeded (i.e., removed) and (d) the design is applied to a blank product.

Fig. 2. Examples of goods made using cutting plotters: (a) a vehicle decal made from vinyl that was cut in a plotter, (b) a painted wooden sign that was made using stencils that were cut in a plotter, and (c) apparel that was made using heat transfer vinyl that was cut in a plotter and applied to a shirt using a heat press.

Once the material has been cut, the user removes the mat from the plotter, and 'weeds' any excess material using tweezers or a pick (Fig. 1c). Depending on the end goal, a user may adhere the design to a blank surface or product (Fig. 1d, 2a), or use post-processing techniques, for example, placing a stencil on a wood board and painting the board (Fig. 2b) or embedding the design into a t-shirt using a heat press (Fig. 2c). Although plotters have been historically used by sign shops to cut adhesive vinyl for signage, car graphics, and wall decals, smaller desktop versions of plotters have become commonplace in makerspaces and homes because they can cut a variety of crafting materials (i.e., paper, cardstock, adhesive vinyl, heat transfer vinyl, thin fabrics, felts, and foams, stencil materials, and so on), they are safer than other personal fabrication machines (i.e., no fumes are produced or lasers used), they have decreased costs (i.e., ~$300 to $500 CAD plus materials), they are portable (i.e., ~2 to 5 Kg), and they require less technical knowledge (i.e., there is no requirement to understand blade angles, blade pressures, or calibrate blade depths for different materials).

The two most common desktop cutting plotters are "Silhouette" and "Cricut". They both support the cutting of materials that are 12" wide and utilize USB or Bluetooth connections to connect the plotter to a computer. One major difference between the two types of machines is that the Silhouette relies on offline software to create designs and run the plotter, whereas the Cricut uses an online web-based platform and offers pre-packaged cartridges with designs. The Silhouette also offers an optional software plugin that can be integrated within CorelDraw or Adobe Illustrator. In addition, Silhouette offers many enhanced features that Cricut does not, i.e., automatic pagination of designs across multiple sheets of material, the ability to simultaneously send a design to multiple machines, .svg import and export options, the cutting of materials up to 10 feet long, and the ability to continue editing a design while the machine is cutting. More advanced versions of both machines (i.e., the Silhouette Curio and Cricut Maker) can also stipple and engrave aluminum sheets, cut thin balsa wood, emboss materials, and more.

4 DATA COLLECTION METHODOLOGY

To better understand the opportunities that personal fabrication technologies and social networking platforms have afforded crafters across Canada, a mixed-methods research methodology [29] using both an online survey and follow-up phone or video-based interviews was used. The use of surveys and interviews allowed for a general exploration of the population who participates in personal fabrication-based entrepreneurship from the survey and a more focused, nuanced understanding of participants' specific practices and their contexts, challenges, and motivations from the interviews. This mixed-methods approach was used to overcome some of the challenges inherent in the direct observation of participants such as access to respondents or interviewees who lived in remote communities [136], offering flexibility to respondents to participate in the survey and interviews whenever it would minimize disruptions to their already busy lives [40, 136] (i.e., those caring for newborns or young children or those who only have time to work on their businesses after 9 or 10 pm local time), preventing intrusions into the private spaces where these activities take place (i.e., participants' households where they have children or others they care for full time), and in the case of the survey, ensuring that respondents could report on their practices and experiences while remaining anonymous [21].

While some advertising practices, competition strategies, or troubleshooting techniques may not generalize outside the Canadian context, many other communities of crafters around the world use cutting plotters as well (e.g., USA, UK, Australia, Germany, Italy, France [52]). In

addition, Canada is ethnically and socioeconomically diverse, and respondents were geographically distributed, representing both urban as well as suburban and rural communities. These findings should thus still shed valuable light on the opportunities and challenges of using personal fabrication equipment in the home for entrepreneurial purposes.

4.1 Online Survey

To understand the challenges, opportunities, and contexts of homepreneurs who use cutting plotters, an online survey was written in English and contained 23 closed questions and 22 open-ended questions (Appendix A). The series of closed questions allowed for the collection of quantifiable data relating to demographics, cutting plotter type and usage, the artifacts made by participants, the materials used, where design ideas come from, where new skills were learned, where goods are sold and advertised, and so on, using an instrument that would be quick and easy for respondents to complete [120]. For closed questions where respondents were provided with response options to choose from, the options were derived from Vagias' recommendations for Likert-scale response anchors [133], lists of materials, supplies, and equipment that were aggregated from cutting plotter manufacturer websites or in buy-in groups (e.g., lists of materials that could be cut on the machines or products available for purchase), or common questions and answers that appeared in Canadian Facebook groups for desktop cutting plotters. The survey also contained open-ended questions to enable respondents to provide spontaneous, nuanced, qualitative information that was not prompted by potentially biased suggestions and also gave respondents the opportunity to relay personal anecdotal stories or situations [37, 70, 120]. These open-ended questions asked respondents about their motivations for using their cutting plotter, the frustrations they encounter, what they enjoy making, why they do or do not make replicas of licensed items, and how they handle competition from other homepreneurs. The survey questions were modelled after questions used in prior work and the themes that were reported in this literature (e.g., 2, 3, 24, 38, 43, 46, 49, 60, 62, 63, 82, 83, 96, 101, 98, 130). The survey took respondents an average of 24 minutes to complete (range = 11 to 73 minutes).

The survey was advertised within four popular, active Canadian Facebook groups for desktop cutting plotter users to approximately 3000 people. None of the members of these groups were required to be homepreneurs for acceptance in the group. Facebook groups were used to recruit participants because, unlike other communities where message boards, forums, or in-person meetups are commonplace [61, 131, 135], users of these plotters congregate online, within Facebook groups that target the brand of plotter they have. As of May 2020, for example, there were over 100 public Facebook groups worldwide devoted to Cricut cutting plotters and over 60 to Silhouette cutting plotters. Respondents were asked screener questions to ensure they ran a "business" in Canada and had sold at least five goods to clients that were not family members or friends in the last two months. Respondents were provided with a $15 CAD gift card as an honorarium for completing the survey.

4.2 Semi-Structured Interviews

To better understand the responses provided in the survey data, all survey respondents that indicated they would be willing to participate in a follow-up interview were contacted. Nine accepted invitations to be interviewed and were interviewed via phone or video calls for approximately 40 minutes. A $50 CAD gift card was provided as an honorarium for their time. The semi-structured follow-up questions were focused on gaining deeper insights into their answers to

the survey and probed topics including work/life balance, process and troubleshooting workflows, advertising and research activities, feedback from others, business decisions, and after sale support (Appendix B). All interviewees responded to questions about work/life balance but depending on the nature of the conversation and the type of business they ran, they may or may not have been asked questions about all the remaining categories. Each interview was audio recorded and then transcribed using the audio transcription service Temi[1].

4.3 Data Analysis

The descriptive statistics presented herein for the responses to the 23 closed survey questions were computed using Microsoft Excel. To analyze the responses to the 22 open-ended survey questions and the follow-up interviews, an inductive thematic analysis method loosely following that of Braun and Clark was used [18]. All the transcribed interview comments and survey responses were reviewed and compiled into one document, where each section of the document contained answers to a single question or to a survey and interview question that were related (e.g., a survey question about frustration with one's machine and interview responses about steps taken to overcome issues with machines). Similar to Meschi [94], each section was then printed onto standard 8.5" x 11" sheets of paper and manually cut into strips, with one main antidote, story, or thought per strip (Fig. 3), resulting in more than 450 individual strips. Rather than writing codes on each strip and having to search and reorganize all strips by code, the strips were organized into code-based clusters and labelled with Post-it notes. Due to the nature of the open-ended survey questions, most of the strips only contained data that corresponded to one code, however, strips that contained multiple codes were photocopied and placed in each code-based cluster they corresponded to.

Fig. 3. The responses to each question were printed on paper and then cut into strips and clustered based on the sentiments in each strip. The blue post-it notes identified which code applied to each cluster. These strips were then continually merged and re-clustered over multiple days. This image shows the process midway through the cutting of the responses into individual strips with a few codes initially placed on some clusters.

[1] temi.com

Once all the strips were cut and initially clustered, they were then used in a multi-day affinity diagramming exercise [123] that was conducted on the floor (due to the quantity of strips). Working cluster by cluster, each strip within the cluster was further clustered in sub-clusters or merged within another cluster based on the sentiment on the strip and those in the current cluster. As clusters were compared and reviewed, new clusters were found so clusters and sub-clusters were reorganized, merged, and recoded with new Post-it notes as needed. At the conclusion of this activity, all the coded Post-it notes were organized and combined into themes that described the overarching data relationships they contained. This iterative process continued with all coded Post-it notes until there were approximately 30 themes that remained.

Some of the resulting themes that are reported herein mirrored the questions that were asked in the survey and interviews (e.g., economic motivations, technical issues), whereas others such as the importance of personalization, the always on nature of these businesses, and the software mashups that these homepreneurs used, were novel. Overall, the data analysis resulted in the identification and understanding of the many workflows, strategies, challenges, and opportunities that desktop cutting plotters afford homepreneurs.

5 FINDINGS

The data analysis revealed the flexibility, economic, and emotional benefits that personal fabrication machines offer these homepreneurs. It also revealed the many workflows that these homepreneurs use to design and manufacture items for clients, the effects of these workflows on their home lives, the obstacles that using digital technologies to create physical goods introduce to at-home, personalization-based businesses, and the implications of using social media to sell in local markets that are highly saturated and competitive.

5.1 Respondent Demographics and Cutting Plotter Usage

Forty-nine respondents completed the online survey, all of which identified as female (Fig. 4). The average age of respondents was 37 years (range = 25 – 60 years). Seventy-eight percent of respondents had a tertiary education, which is higher than the Canadian national average of fifty-four percent [128]. Only one respondent had a formal education in graphic design, however, four had business or marketing backgrounds. The rest of the respondents had tertiary educations in areas such as office administration, legal assistance, agriculture, archeology, food science, bioethics, and so on. Sixty-nine percent of respondents also had at least one child under the age of eighteen that lived in their home.

Although Silhouette cutting plotters can cut material that is longer and the plotting software has more features and is offline rather than browser-based, only twenty-two percent of surveyed homepreneurs use this brand of machine. The majority of homepreneurs (i.e., 67%) use Cricut cutting plotters, which retail for the same price as Silhouette cutting plotters but have a shallower learning curve due to their more simplified, limited software. Ten percent of surveyed homepreneurs owned cutting plotters from both companies. In terms of usage, seventy-one percent of survey respondents used cutting plotters for more than two years; four percent used their plotter a few times a month, twelve percent at least once a week, forty-seven percent multiple times a week, and thirty-seven percent used it every day. Fifty-seven percent of surveyed homepreneurs devote more than ten hours each week to their business and twenty-two percent devote more than 20 hours each week. Half of the surveyed homepreneurs run their businesses entirely by themselves (53%), whereas the other half ask their children, spouse,

friends, or extended family to help them from time to time (47%). They also do not travel to communal workspaces or makerspaces [20] and instead work in their kitchen, craft room, home office, basement, living room, and so on. When asked if their business was a full-time job, eight percent of respondents reported that it was, twenty-two percent considered it to be a part-time job, forty-five percent thought of it as a hobby, and twenty-four percent viewed it as both a hobby and part-time job. Although homepreneurs spend many hours on their businesses, thirty-three percent do not track their profits. Fifty-three percent of respondents reported making a profit of less than $4,999 CAD a year. None of these respondents reported taking on a loan or investments to start their business, which is similar to findings about those who use other personal fabrication technologies as part of their business, but different from those who run more traditional small businesses such as restaurants or boutiques [83, 101].

Respondent	Gender	Age	Children < 18 yrs at home?	Brand of Cutting Plotter	Years Owning Cutting Plotter	Cutting Plotter Usage	Others help with my business?	Profit Per Year (CAD)	My Business is ...
S1	F	41	Yes	Cricut	2	A few times a week	Yes	Less than $1000	Hobby
S2	F	37	Yes	Silhouette	> 10	Every day	No	$10,000 - $24,999	Hobby / Part Time
S3	F	52	No	Cricut	2	A few times a week	Yes	$1,000 - $4,999	Hobby
S4	F	45	Yes	Both	5	A few times a month	Yes	Don't track	Hobby
S5 / I1	F	40	No	Both	3	A few times a week	No	Less than $1000	Hobby
S6	F	52	No	Both	< 1	A few times a week	No	Less than $1000	Hobby
S7	F	30	Yes	Cricut	3	A few times a week	No	Don't track	Hobby
S8	F	32	Yes	Cricut	> 10	Once a week	No	Don't track	Part Time
S9	F	56	No	Cricut	4	Every day	Yes	$1,000 - $4,999	Part Time
S10	F	29	Yes	Cricut	3	Every day	No	Don't track	Hobby / Part Time
S11	F	46	Yes	Cricut	2	A few times a week	Yes	Don't track	Hobby / Part Time
S12	F	35	Yes	Silhouette	3	A few times a week	Yes	$1,000 - $4,999	Hobby
S13	F	31	No	Silhouette	3	Every day	Yes	$1,000 - $4,999	Part Time
S14	F	30	Yes	Cricut	3	Every day	No	$50,000 - $79,999	Full Time
S15	F	41	Yes	Silhouette	3	A few times a week	No	Less than $1000	Part Time
S16	F	32	Yes	Cricut	3	A few times a week	Yes	Don't track	Hobby / Part Time
S17	F	29	No	Cricut	2	A few times a month	Yes	Less than $1000	Hobby
S18	F	38	Yes	Cricut	3	Every day	Yes	Don't track	Part Time
S19	F	27	No	Cricut	2	A few times a week	No	Less than $1000	Hobby
S20	F	37	No	Cricut	10	A few times a week	No	$5,000 - $9,999	Part Time
S21	F	41	Yes	Silhouette	3	A few times a week	No	Don't track	Hobby
S22	F	28	No	Cricut	10	Once a week	Yes	$1,000 - $4,999	Hobby
S23	F	27	Yes	Silhouette	3	Every day	No	$5,000 - $9,999	Part Time
S24	F	37	Yes	Cricut	3	A few times a week	Yes	$1,000 - $4,999	Hobby / Part Time
S25	F	42	Yes	Cricut	4	A few times a week	No	Less than $1000	Hobby
S26	F	40	Yes	Cricut	3	A few times a week	No	Less than $1000	Hobby
S27 / I2	F	56	No	Cricut	2	A few times a week	No	Less than $1000	Hobby
S28	F	36	Yes	Cricut	> 10	A few times a week	No	Don't track	Hobby
S29	F	25	Yes	Both	2	Every day	Yes	$10,000 - $24,999	Full Time
S30 / I3	F	34	Yes	Cricut	3	Once a week	No	Less than $1000	Hobby
S31	F	25	No	Cricut	1	Once a week	No	Less than $1000	Hobby
S32	F	38	Yes	Cricut	3	A few times a week	No	$1,000 - $4,999	Hobby
S33	F	60	No	Cricut	4	Every day	Yes	$1,000 - $4,999	Hobby / Part Time
S34	F	35	Yes	Cricut	4	Every day	No	Don't track	Hobby
S35	F	56	No	Silhouette	> 10	Every day	No	Don't track	Part Time
S36 / I4	F	35	Yes	Silhouette	1	A few times a week	No	Less than $1000	Hobby / Part Time
S37	F	33	Yes	Cricut	2	Once a week	No	$1,000 - $4,999	Hobby / Part Time
S38 / I5	F	45	No	Silhouette	4	A few times a week	Yes	Don't track	Hobby / Part Time
S39	F	38	Yes	Cricut	2	A few times a week	Yes	Don't track	Hobby / Part Time
S40 / I6	F	36	Yes	Cricut	3	Every day	Yes	$5,000 - $9,999	Part Time
S41 / I7	F	32	Yes	Cricut	2	Every day	Yes	$5,000 - $9,999	Full Time
S42	F	52	Yes	Cricut	2	Every day	Yes	Don't track	Hobby / Part Time
S43 / I8	F	35	Yes	Cricut	10	Every day	Yes	Don't track	Full Time
S44	F	30	Yes	Cricut	5	Once a week	No	Don't track	Hobby
S45	F	25	Yes	Both	3	Every day	Yes	$1,000 - $4,999	Part Time
S46	F	30	Yes	Cricut	3	Every day	No	$1,000 - $4,999	Hobby / Part Time
S47	F	35	Yes	Silhouette	3	A few times a week	No	$1,000 - $4,999	Hobby
S48	F	38	Yes	Cricut	3	Every day	Yes	$1,000 - $4,999	Part Time
S49 / I9	F	29	No	Silhouette	6	A few times a week	No	$1,000 - $4,999	Hobby

Fig 4. Demographic information about respondents, their cutting plotters, and their businesses. Note that in the Respondent column, 'S' denotes that the respondent responded to the survey and 'I' denotes the respondent also participated in a follow-up interview.

The most popular goods that respondents mentioned personalizing were glassware, apparel, wood signs, decals, tumblers, mugs, and holiday décor (Fig. 5 top). They also mentioned more unusual goods such as tea towels, light-up camping buckets, ceramic tiles, personalized sandals, and packaging for candles or candy. In addition to cutting plotters, these homepreneurs also use an iron or heat press to adhere vinyl to clothing (94%), light hand tools (e.g., squeegees, tweezers, picks, etc.; 90%), manual tools (e.g., saw, hammer, hand sander, etc.; 63%), and power tools (e.g., drill, miter saw, jigsaw, orbital sander, etc.; 61%). None of the respondents used personal fabrication equipment such as 3D printers, laser cutters, or CNC routers. This was reportedly due to the cost of the equipment (80%), space limitations (31%), the cost of materials (18%), a lack understanding about how the homepreneur could integrate them into their workflow (18%), and time that was perceived to be needed to learn how to use them (16%).

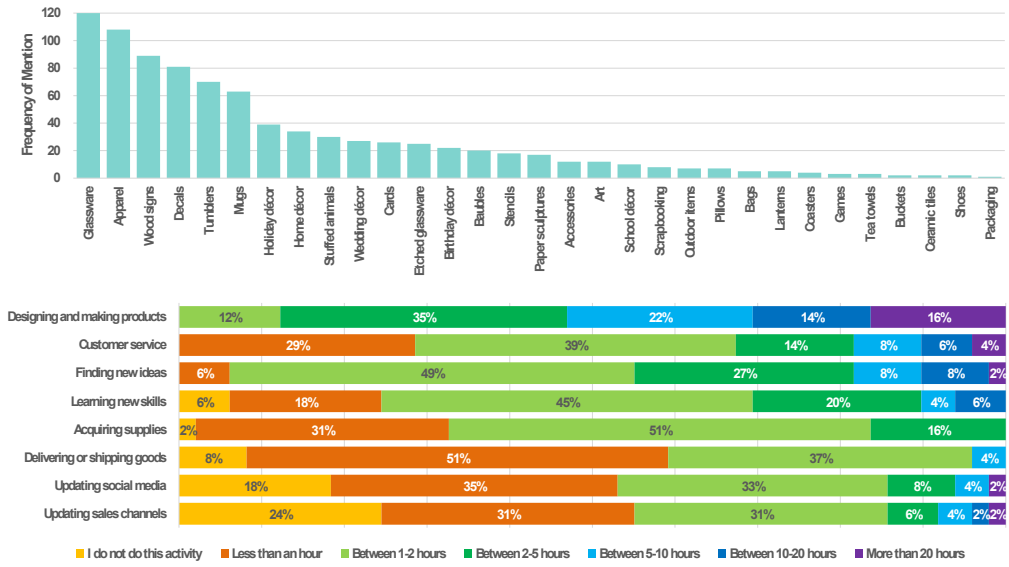

Fig 5. (Top) Goods personalized or made using cutting plotters that were mentioned most frequently by respondents in the online survey. (Bottom) An estimation of the time homepreneurs spend per week on various tasks for their businesses.

In addition to buying supplies from local, "high touch" sources [122, 132] such as sign shops (65%) or craft stores (76%), about a quarter of surveyed homepreneurs also buy supplies from "buy-in" groups (24%). Buy-in groups are local Facebook groups where an administrator collects small orders from a large number of buyers, for example, 5 to 30 water bottles per person, and places one wholesale order for hundreds or thousands units on behalf of the entire group with a distributor or manufacturer in Asia or the USA. This practice is similar to shared purchasing [138, 139] but different from group buying on websites or tuángòu [94]. Buy-in groups enable homepreneurs to buy materials at or near the cost of manufacture without needing to take on an entire inventory, however, they come with the added risks of blanks not being as described, orders arriving late or getting lost in the mail, the administrator disappearing and taking everyone's money, and their local competition also having access to the same blank goods.

5.2 Homepreneurs' Motivations

The motivations and reasons why homepreneurs started and continued to run their businesses were both opportunistic and necessity-driven [63]. They mirrored the eight motivations of gig workers and service providers identified by Bellotti et al. [16] relating to values, social connections, status and power, empathy/altruism desires, instrumental (economic) needs, social influence, safety, and intrinsic/autotelic needs.

Many businesses (65%) grew organically out of crafting practices and were motivated and cultivated by social connections. In these cases, the homepreneur was given a cutting plotter as a gift or they bought it for themselves to make wedding invitations, birthday gifts, etc., "*for my wedding decor! why pay someone when you can do it yourself!!*" (S17). After making crafts for themselves, some homepreneurs posted images to Facebook or Instagram. These images then generated requests from friends, family, and co-workers, so they began offering goods for sale, *"I really enjoyed crafting and was getting a lot of complements about my work. I realized selling was a way to support my crafting habit while doing something that I loved"* (S28). For others, plotters filled more instrumental needs, with homepreneurs having the explicit intention of starting a business for additional income (31%). These homepreneurs bought their machines using personal savings [92]. Many did this out of necessity, due to job loss or to pay for medical expenses, for example, "*I started my business two years ago when my grandson was diagnosed with Type 1 diabetes, it was to help my daughter and hubby with the expenses"* (S33) and *"I needed to provide extra income for myself and my autistic son"* (S27).

Some respondents were also extrinsically inspired by the social influences of friends or family, perhaps by the status and power they could obtain within their extended family or local community if they had their own business, for example, *"my sister-in-law had a Cricut machine and I saw all the amazing things she made with it"* (S31) and *"my sister upgraded from her Cricut mini … I did the first little intro thing Cricut had you do and bingo bango I was hooked!" (S34).* Others had more intrinsic reasons, largely resulting from the newfound time they had due to medical conditions or pregnancy, for example, *"I was recovering from cancer surgery and I wanted to do something different"* (S3) and *"I was on maternity leave, so I had extra time"* (S28). These activities also were viewed by some as a form of therapy (e.g., "*I also deal with depression and sometimes the creative process helps alleviate some of the symptoms*" (S27), "*it's a way of getting creative and stepping away from the stresses of my full time job" (*S24), and *"I find crafting and being creative relaxing so it is my self-care*" (S12)) or self-improvement (e.g., *"it gives me confidence in myself, something I lost 36 years ago!"* (S33)), highlighting the importance of value or safety-based motivations as well.

Lastly, a few respondents mentioned more empathic and altruistic reasons for starting a business such as a desire to help or make things for others (e.g., "*I like being able to use my creativity to make things for others that they can enjoy" (S39),* "*I wanted to make shirts for people with disabilities that were empowering and celebratory – I am a special needs parent and there is a need for goods by people who 'get it' in the community"* (S12), and "*I created a Game of Thrones House Stark Banner for my nephew. I used my sewing machine to sew up the 2' x 4' canvas banner, then used Design Space to lay out the design and the Cricut Explore One to cut the stencil. I painted the background with fabric paints, laid down the stencil, and filed in the base coat with fabric paint and removed the stencil. My autistic son used another editing program to create the wording for the*

design, and I brought those into Design Space, cut stencils for the words, and again used fabric paint to paint in the wording. I enjoyed using all the various equipment and materials in harmony with each other and working with my son." (S27)).

To use Bellotti et al.'s terminology [16], these homepreneurs don't officially play the role of both user and service provider because they don't provide their materials, techniques, networks, or business practices to others. Many examples of Bellotti et al.'s eight motivations, however, were still found with these homepreneurs. Because homepreneurs do take on some of the roles more commonly held by service providers and use digital technologies to do so, such as finding their own clients on platforms such as Facebook (instead of being assigned them) and determining how much to charge for their services by searching for what their competitors are charging online, it is possible that these homepreneurs are acting as hybrid user-service providers and their cutting plotter-based businesses are a new category of "gig" within the context of the current digitally-mediated sharing economy.

5.3 Lifestyle Effects of At-Home, Personalization-Based Workflows

One surprising, yet prevalent theme within the data were the effects that running an at-home, online business has on homepreneurs' lifestyles and environments. In what follows, the generalized workflows that were reported are discussed, in addition to an identification of the ways these workflows limit the time homepreneurs have with their families and the physical footprints these activities take up within their homes.

5.3.1 Personalization-Based Workflows. Although cutting plotters precisely cut graphics or text out of raw materials, these homepreneurs must design, mashup, edit, or buy graphics to be cut and then apply them to a good. Thus, these homepreneurs have limitless opportunities to create personalized graphic designs and offer personalized goods at price points that are accessible to lower- and middle-class clients [83], i.e., "*my power is in personalization*" (S37). While some of these homepreneurs offer generalized, 'ready-to-ship' goods, "*I have made around 100 pillows with the same poem on them for grandmas ... they are very popular*" (S48), the majority make and personalize a wide variety of niche, bespoke goods on-demand (e.g., "*Enbridge Ride to Cancer car vinyl wraps*" (S5), "*a grandma a family birthday sign with all her family birthdays on it*" (S22) and "*a shadow frame birth announcement that had the baby's name on it*" (S8)). They thus have a great degree of control and agency over the orders or tasks that they choose to take on and can cater to specific niche clients and underserved markets [6, 83].

Because these homepreneurs do not use a centralized social economy or e-commerce platform to run their businesses, they do not have access to applications or algorithms that will match their goods to specific client demographics or needs like current gig economy workers have [68, 69, 75]. Thus, like homepreneurs in Saudi Arabia [2, 3], these homepreneurs must actively find their clients themselves, so many turn to social media platforms. The general strategy most homepreneurs reported following when attracting clients and making personalized goods was to upload images to a 'catalog' on a website, marketplace, buy-and-sell group, Facebook album or business page of (i) goods they have already made for others or (ii) digital renderings of designs on blank items they think clients would like. Clients then request an item from the 'catalog' with a specific color, size, font, name or other personal details by sending a message to the homepreneur via the homepreneur's Facebook page, commenting on the photo or post on Facebook or Instagram, sending the homepreneur an email or text message, or by calling the homepreneur on the phone. Then, homepreneurs either begin

manufacturing the good(s) for their client or do so after receiving a deposit from their client. Once the good is manufactured, the client then comes and picks up the good(s) from the homepreneur at their home (88%), full-time job (10%), a common public location (63%), or it is delivered to the client at their home or business by the homepreneur (65%) or a courier or the postal system (45%). Payment is made once the good is complete or upon pickup or delivery. The use of a catalog to advertise wares is largely similar to that found with Songket weavers [138, 139] and Saudi Arabian homepreneurs [2, 3].

Alternatively, if clients already know about the homepreneur, perhaps through word of mouth or working with them in the past, then a more personalized production workflow is often followed. With such a workflow, a client can send images from Etsy, Pinterest, or Google Images to the homepreneur through one of the aforementioned channels and ask them 'recreate' or 'reimagine' the design on a good. Interviewee I7, summarized this workflow best: "*I put up [pictures of] what I can personalize on my Facebook page so people can kind of scroll through and see what I've got and then they could say, 'oh, I saw you did this, can you do something similar but maybe in purple or whatever' ….. I would say probably 70% of people already have a graphic or a quote or something that they want and then the rest are whatever I want to design, they'll say 'as long as it is purple you can surprise me'*". Homepreneurs then often make several digital mockups of the design or personalized good in their plotter design software or another program such as Illustrator or Inkscape and send screenshots to the client via email or Facebook Messenger. The client and homepreneur then work through an iterative co-creation design process, with the client making suggestions about the digital graphics and the homepreneur making modifications to the digital graphics until the homepreneur arrives at a design they both agree on.

These personalization activities [17, 56] are similar to those performed by practitioners of intangible cultural heritage in China who use livestreaming platforms to sell commissioned goods [89], in that there is an iterative co-design process between the homepreneur (practitioner) and the client (viewer) that enable all parties to have a sense of agency and emotional fulfillment throughout the process [34]. However, with these Canadian homepreneurs, the co-design process occurs offline, over email. While the offline nature of their work can allow homepreneurs to better recover from errors or mistakes and ensures that their process and workflow remains private, it does add additional burdens on the part of the homepreneur. Because homepreneurs devote a great deal of time to the co-design process (Fig. 5 bottom) they must spend additional time tracking down clients who do not respond or end up in a seemingly never-ending co-design cycle with indecisive or demanding clients, e.g., "*sometimes clients are very unrealistic on turnaround times or the abilities of my skills or they change their mind*" (S24) and "*people can be difficult and as a seller, sometimes you need to invest more time into a single client's design to maintain your image and 5-star brand*" (S31). This personalization production workflow is also different than other online, on-demand customization services such as Vistaprint, Zazzle, or RedBubble where buyers select a destination form factor, choose their color, artwork, and design choices on a website, and pay in advance [48, 106]. With these services, sellers manufacture goods to specification, with little or no contact with the client or latitude to co-create. However, in contrast to Vistaprint, Zazzle, and RedBubble, which must carry an inventory of standardized goods, the small-scale, personal nature of these homepreneur workflows enable homepreneurs to customize and add value to virtually any good that they can acquire. Thus, clients are not required to order goods in

specific quantities or meet order minimums, so they often request one-off, bespoke goods that cater exactly to their tastes.

5.3.2 Lifestyle Influences. In addition to handling day-to-day life responsibilities, these homepreneurs must also find clients and maintain relationships with them, acquire materials and supplies, produce goods, and research new avenues to grow their business [10]. When these demands are coupled with the "*want it now*" mentalities of clients [11] and the boundless time that clients perceive homepreneurs have (because, unlike Instacart, Skip the Dishes, or TaskRabbit gig workers, the fulfillment of client orders is not perceived to be restricted by the operating hours of retail outlets or restaurants), clients often have the expectation that they can directly reach out to homepreneurs via private or public channels to receive personalized, on-demand service at all hours of the day. Thus, homepreneurs continually feel pressure to respond to clients and fulfill orders, e.g., "*I do not turn it off. I work all day, while also taking care of my daughter, and all night. I sleep 3 am to 6 am.*" (S14) and "*I spend too much time trying to get a product made in time for a client and this ends up reducing the amount of time I have for my home life (cooking, cleaning, sleeping, playing with my children)*" (S47). Similar to other gig economy workers on services like Fiverr or Etsy, the "always on and available" nature of these businesses often prevent homepreneurs from being able to "turn off" their businesses [32, 35] because their supplies are in view and easily reachable while they are caring for children or spending time with their family. Unlike those who work for ride sharing services who can simply turn off a gig app, park their vehicle, and go home, these homepreneurs' places of calm and relaxation are intertwined with their place of business.

If they wanted to overcome these pressures, some homepreneurs simply limited the number of orders they accepted or raised their prices to ensure that the time they were devoting to their business was reflected in the income they could be receiving. A few homepreneurs also decided to set schedules and explicit hours to work on orders, choosing to ignore requests or messages that came in after hours. For I9, for example, "i*n the beginning I felt bad when I didn't dispatch an order is fast as humanly possible but then I was like, 'they will get this when they get this, this is not saving a life' …. I set aside time to do my orders twice a week in the evening and if it does not get done in that time, oh well*". This homepreneur created what they perceived to be a healthy work life balance but did so at the cost of delaying order fulfillment and thus sacrificing potential client happiness, positive reviews, and future orders.

When asked if they would rather simplify their businesses and streamline their offerings to eliminate the time they spent designing artwork, some homepreneurs reported that although they found the time demands and financial benefits stressful, they still saw value in being part of the entire pipeline, e.g., "*I do not enjoy designing on the computer as much … I'm more hands on but I do like the reward of finishing a complicated design someone requested"* (I1), *"there is value to having a predesigned and precut system … for like wood sign painting parties and stuff … but I like all of the nitty gritty stuff … I like the design and working with barn boards and the whole process"* (I7), and "*it's hard cause somedays I do enjoy creating, especially if someone comes to me and says, 'oh, I want this with this', I like being able to come up with something for them … when you come up to those holidays like Valentine's day or Father's day it would be nice to not have to sit and think of something that nobody else is offering*" (I8). Another homepreneur, I9, disliked the idea of impersonal personalized manufacturing, nothing "*there's no expert knowledge in file, open, print, cut, etc. there's no creativity involved in that … anybody can do that so I wouldn't want to be in an industry where I am continually doing repetitive tasks".* Similar to DIY'ers [9], the

design and creation of artifacts has become ingrained in I9's identity and motivation for having her business so she could not imagine running a business that didn't let her have the agency and intrinsic motivation she desired throughout her entire personalization pipeline.

As personalizing items for clients requires both digital design work and physical assembly tasks, in addition to online client service activities, homepreneurs often end up combining the physical spaces where they work and live to respond to messages, make designs, and create goods at all hours of the day (Fig. 5 bottom). Many of the surveyed homepreneurs use communal areas in their home for their entrepreneurial activities so they can have time with their children and family, e.g., *"I should have a dedicated workspace, but my house is full of supplies so the Cricut is mostly in the basement because the Cricut itself is wireless … my computer moves around for the design work so sometimes I'll just pop downstairs and cut an order quickly but sometimes I like to just sit with the family upstairs and design and assemble an order*" (I5), "*all my artistic stuff, my crafting stuff, it's literally, you know, in cupboards, bookshelves and stuff in my living room, I actually have two kitchen tables in my living room … one is designated for all my sewing stuff the other one is for my Cricut machine and vinyl and stuff like that on it so everything is in easy reach*" (I2), and "*I actually have long term goal where basically the plan is that we have one on each floor of my house because I need the space, but most work is currently being done in my kitchen and office"* (I6). Others, such as I3, did create deliberate physical boundaries to ensure they had distinct work and home life spaces, i.e., I3 used an office at the front of their house exclusively as a workspace and meeting space for clients, e.g., "*so when I do have people come over, the office has a door so I can close the door if we need and people aren't walking through the entire house …. the office is at the front of our house and the window actually looks out to our front door too so I can see people coming and going if they pick up from outside too*". Although this physical separation was found to be helpful by this homepreneur's family, it also meant that this homepreneur was sacrificing physical space within their home to run their business – something not all homepreneurs may have the resources or permission to do (e.g., "*I don't have people come into the house because I live in military housing that I have to go through a whole set of approvals with the base for that to happen and I'm not willing to do that so they pick up from a bin on my porch*" (I6)). Thus, the "always on" nature of these homepreneurs' businesses and the entrepreneurial activities they undertake have resulted in them having little (physical) separation between their spheres of home and work [47]. These findings are similar to the blending of work and home environments found with organic farming families that were studied by Leshed, Hakansson, and Kaye [79].

5.4 Obstacles When Using Digital Platforms for Homepreneurship

Although personal fabrication technologies have provided many new avenues to unleash creativity and start businesses via personalization, the software, plotters, materials, and online platforms homepreneurs use erect many roadblocks. The survey and interview data revealed several unique practices that these homepreneurs have adopted that illustrate the cumbersome software toolchains and mashups that are prevalent, the material and hardware limitations that they encounter, and the widespread appropriation of online and community-based content that exists within this community.

5.4.1 Software Mashups. Cutting plotters come with free design tools as part of a plotter's software, however many homepreneurs find these tools limited in features, functionality, and

stability (i.e., *"I get frustrated by the inability to separate script text, offset, expand, shadow text, etc."* (I9), *"the machine cutting process is slow and I can't change or edit designs while the Cricut is cutting"* (S23), and "*the Cricut Software freezes quite often and stops in the middle of a design*" (S10)). Many of the issues related to the online-only nature of the Circuit Design Space software, i.e., fifty-five percent of Cricut software users, for example, stated that their machine would stop cutting whenever the connection between the design program and plotter was lost. This resulted in them (i) losing their design progress because all designs made in Design Space must be saved in the cloud and (ii) wasting material because the machine would stop mid-cut and they had to restart the cutting process from the beginning. To overcome these issues, seventy-three percent of homepreneurs reported integrating free tools such as Inkscape, Ribbet, Gimp, or Microsoft Paint, or paid tools such as Adobe Photoshop, Illustrator, or Corel Draw, into their workflows. Homepreneurs reported creating and editing a design in an external software program, importing it into plotting software as an .svg file, and then only using the plotting software to cut the file (i.e., "*I often design work in Corel Draw and then import it so I can use their platform as little as possible*" (I7)). If changes are needed, they must go back to their design program, edit the design, re-export it, and then re-import it into the plotting software.

Because many of these homepreneurs do not have training in graphic design, photo editing, or illustration, homepreneurs who only used plotting software for design reported using one of two practices to create all the graphics they needed for their business. Many used .png or .jpg images or mockup backgrounds of common blank products such as serving trays, coffee mugs, water bottles, and so on that they got from Etsy or suppliers. They then imported these graphics into their plotter design software, added a text and a digital preview of the cuttable design they created in the plotter software, and took a screenshot of the result. They then sent these screenshots to clients for approval, posted them on social media to generate interest in their business, or used them in their catalog or on their website to advertise the items they have for sale. This toolchain not only enables these homepreneurs to work around their limited graphic design skill sets and create the images they need, but it also saves them money because they do not need to waste materials to physically create an item. The downside for clients, however, is that they must make purchasing decisions based on a digital mockup of a product that the homepreneur may not have the skills to create or supplies to make.

Other surveyed homepreneurs reported stringing together collections of free, mobile or desktop software tools such as those used to create graphics or add text, watermarks, or logos. They then export and import the results from one program to the next, for example, "*I use a website or app called ipiccy and create collages of wherever designs I have available then I bring them into a watermark app and then put it into [Cricut] design space and add text and write down the names under each one or how much they are or whatever and then load that to the buy and sell groups*" (I2). This second process enables homepreneurs to reuse existing digital content they have (thus saving them material costs) and demonstrate to clients that they have the skills to create the items they are advertising, but this process is complex and cumbersome because it requires that the homepreneur to not only remember the software toolchain, but also backtrack through each tool whenever changes are needed.

5.4.2 Hardware and Material Hiccups. Unlike other personal fabrication equipment, cutting plotters need little setup, servicing, or maintenance. While this has allowed homepreneurs who are not 'crafty' or 'techy' to quickly get started, troubleshooting problems is difficult because plotters are perceived to be 'black boxes'. As the materials are not standardized, vinyl from one

brand, for example, many require different cut settings and post-processing techniques than vinyl from another brand (e.g., "*getting the blade depth perfect is hard ... the factory settings for permanent vinyl do not always work for me for all types of permanent vinyl*" (S14)). Because plotters do not offer any feedback or expose technical errors about problems that occur, many homepreneurs are often unable to identify why a material did not cut as intended or prevent the same issue from happening again in the future. Most often, "*the blade doesn't always cut how it should so I have to sometimes send it multiple times before it cuts all the way*" (S1) or *"the cut lines don't always meet so I had to use an eXacto knife to help cut the vinyl by hand"* (S32). These practices end up wasting material or increasing the time spent cutting a design. If scissors or an eXacto knife are needed to fix problems, they can also decrease the precision and aesthetics of a design.

As these homepreneurs work at home, they also do not have access to the in-person assistance often found in makerspaces [61, 135]. Similar to other material-dependent activities such as woodworking, casting, or embroidery, when working with new materials, many homepreneurs use self-learning techniques [107] such as trial and error (84%) to diagnose and fix issues that arise. They often test out small designs using different settings until they arrive at the correct parameters for a material (i.e., "*I don't mind working with new materials, but they require me to waste so much material because I have to cut and recut over and over until I find the right setting ... but if you replace your blade, you have to do it all over again*" (I4) and "*for materials I haven't used, I have to make sure I have ample time and I can't rush anything because you can't just slide the material in, look up the suggested cut settings online, and use those ... you have to trial and error ... you have to do a test cut with a little square and triangle and see if that works ... with every new material you have to trial and error" (I9)).* As noted by many homepreneurs, these trial and error cycles waste time and material, but not as much as if they were not undertaken. If materials were standardized then perhaps trial and error cycles would not even be needed at all, "*Avery makes labels that have standards ... if I want to print an Avery Standard 8320, no matter of if I'm in Office or Google or anything it's all the same template .... it'd be nice if these materials came with the number or code that I could put into the software so that it would know exactly what it is and what the cut settings should be"* (I9).

Because many of these homepreneurs realize that due to the ubiquity and popularity of cutting plotters, "*if you're having a problem somebody else somewhere else has had it also*" (I1), they often turn to online sources such as YouTube (82%), plotter-specific Facebook groups with thousands of members (78%), or Pinterest (61%) for help, for example "*the first one I'll go to is Facebook groups and then if I can't get that solved then I'll go on Google and look but most of the time I use the Facebook groups*" (I8) and "*there are so many Cricut Facebook groups out there that you can usually find the answer in a couple of minutes*" (I2). Posting on forums or websites [78] or contacting the manufacturer of their plotter is rare because the perceived response times are too slow (i.e., *"I've never contacted Silhouette because I do not have the time to wait for them to respond ... I need an answer in 20 minutes so I can get my order out*" (I9)). Searching rather than posting to channels allows homepreneurs to "just keep moving" [131] by quickly providing the answers they need. Although these practices help them finish orders, they do not inherently teach homepreneurs how to prevent such issues in the future.

Many homepreneurs have also developed cost-saving practices, which due to the limited feedback and functionality of their plotters, can create self-imposed problems. For example, rather than using a new sheet of material for each project, they place material offcuts on a mat

to piece together a design (Fig. 1b). Because their plotting software does not know where materials are on their mat, these homepreneurs must manually align their on-screen design with the material locations on the mat. Incorrect alignment will result in the failure of their cost-saving practice (i.e., "i*f the blade isn't on the proper setting or the material isn't on the mat in the right spot, I need to recut the artwork again"* (S8)). Although plotters could be equipt with cameras to scan and adjust designs to fit material placements [53], this capability would increase the cost of cutting plotters, possibly putting them out of reach of homepreneurs.

5.4.3 The Appropriation of Intellectual Property. One unexpected finding related to the widespread appropriation of intellectual property by, and within, this community. Similar to 3D printing communities [12, 49, 73, 83, 98], the majority of respondents integrate fonts and design elements that they collect from online sources such as Etsy or a designer's website (73%), 3rd party design websites (86%), the Cricut or Silhouette online stores (39%), or images found online via searching (70%). In many of these locations, it can be difficult to determine if content is available for commercial or personal use or requires a license. Although only eight percent of surveyed homepreneurs reported purchasing commercial licenses or had permission to use other's designs for commercial purposes, forty-five percent reported using licensed or copyright content as part of the designs they sold (e.g., sports team logos, cartoon characters, movie quotes, etc.). Some homepreneurs felt that this practice was ok because "*just the Edmonton Oilers .. it's my team!*" (S9) and "*I made six shirts for my friend/client and her daughter who were going to Disney World … they were just so fun to make!*" (S28). Others knew that using such content was illegal, but because they knew there would be demand for the design and they could not afford to legally license the content [41], they were willing to take the risk, i.e., *"Yes. I do not want to pay the high price of the licensed items and I often like to add my own creative twist to it"* (S21), *"I need the income"* (S39), and *"if I do, I never share the photos online"* (S46).

Interestingly, this practice of using existing content is supported by plotter software itself. Within both the Silhouette and Cricut design software, which one must use to cut a design, "trace" functions enable a user to import a .jpg or .png that does not have perspective distortions, watermarks, or is low-resolution into the design software and use color selection tools or thresholding sliders to automatically find edges within an image. These edges are then converted to verbatim vectorized paths that precisely replicate the original image and can be cut by the plotter. Thus, these functions enable homepreneurs to convert non-vectorized images into precise, professional cuttable graphics without needing any graphic design skills. Fifty-one percent of surveyed homepreneurs reported using these functions to create designs. As those who use this functionality do not author the images they are tracing and the images were not posted online or purchased in editable formats, this built-in functionality enables and encourages these homepreneurs to participate in the appropriation of intellectual property.

While some homepreneurs may refrain from using licensed or copyright content from sports teams, animation companies, and so on, not all surveyed homepreneurs believe that content created by those within their own community is actually protected. Fifty-one percent of surveyed homepreneurs reported having their designs or photos used by others in the community without their permission. In many cases, homepreneurs reposted images that other homepreneurs had authored to their own business page or Instagram account. In one instance, a homepreneur who was the content author of a graphic, found a photo of theirs on a different Facebook page and "*replied to the posted image saying it was a gorgeous design and asked if they'd like me to make it for them as I created it*" (S14). In other cases, homepreneurs downloaded

and traced a custom design authored and posted to a Facebook group by someone in the community and started selling the design themselves. Such appropriation was seen as "*aggravating*", "*frustrating*" and "*annoying*" because homepreneurs work hard to stand out within their competitive, saturated markets and such copying dilutes their brand and confuses potential clients about the skills of all homepreneurs in the community. Similar to many other artistic domains, from stock photography to fine art, many surveyed homepreneurs now watermark their images with their business name or logo, adding yet another step to their digital workflow and often obscuring the design they are trying to advertise or get clients to sign off on.

Similar to entrepreneurs in Sweden [108], eighty percent of respondents reported getting ideas and inspiration from groups or their competitors. Although Facebook groups are largely viewed as places of conversation and sharing, in this community, many homepreneurs also use them for the secondary purpose of keeping up to date on their competition. Once a homepreneur becomes established, it is common for them to stop sharing content and answering questions due to fears that they will face a barrage of questions about the processes, workflows, and tricks they spent hours honing and learning, i.e., *"if there is something I am really proud of I'll post a picture but a lot of times I do not because you get 7,000 questions … can you share this file? can you tell me how you did that?"* (I7). While they may be ok providing such details to those not in their immediate local area, many are hesitant to share their "intellectual property" in groups with those who could be their direct competition (e.g., "*I [from Alberta] have a fellow crafter in BC [British Columbia] that I talk with so she understands cause she does the same thing and I have a friend too that's not local and I'm slowly teaching her things as well but I don't post in groups*" (I8)).

5.5 Implications of Selling (Locally) Via Social Media

Lastly, much of the data demonstrated the many effects and self-imposed challenges that arise when these homepreneurs sell goods to clients via local social media channels and their own personal networks. Specifically, the data highlighted how the widespread usage and availability personal fabrication machines has resulted in marketplaces across Canada becoming over-saturated and highly competitive, the effects of this on these homepreneur's businesses, and the unique, one-off practices and techniques that these homepreneurs have adopted to make up for the lack of business functionality that social networking channels and platforms provide.

5.5.1 Highly Competitive, Saturated Markets. Although some homepreneurs have clients located elsewhere in their province (53%), across Canada (39%), or in other countries (16%), all homepreneurs, except one, had a large local client base that bought their goods (98%). Regardless of if they resided in a rural town or large urban city, for these homepreneurs, Facebook was the predominate e-commerce sales channel (86%). Those with a Facebook presence had a Facebook business page (76%), business-based Facebook Group (16%), and consistently posted in local buy-and-sell groups (41%) or local Facebook Marketplaces (43%). None had created a shop on their Facebook business page[2]. Surprisingly, only eight percent of surveyed homepreneurs also had their own website though an e-commerce provider such as Shopify, Squarespace, or Etsy. Other sales channels such as online local marketplaces like Kijiji

[2] www.facebook.com/business/help/912190892201033?id=206236483305742

(33%), renting tables at local craft fairs (37%), or renting space in a local brick and mortar store (14%) were used in combination with Facebook. Those homepreneurs without a Facebook presence relied on word-of-mouth sales strategies involving email, phone calls, or text messages or had tables at craft fairs (12%).

Having a predominately local client base enables these homepreneurs to avoid many of the problems associated with shipping goods to clients such as shipping costs, travelling to the post office, lost or damaged parcels, or incorrectly specified addresses [140], and have effectively pushed "last mile" logistic efforts largely onto their clients [14]. However, because cutting plotters and local (digital) communities enable one to start a business and find clients quickly, it is equally easy for one's competition to do so as well. As I6 recalled, "*A friend of mine, her younger sister also wants to be doing this full time, so I didn't know her at the time, but when I had got my machines she came over and said she just wanted to make stuff. I quickly showed her all this stuff and now she has her own business and of course she usually undercuts everything that I do, and her price is literally 50% of my price.*". Thus, because cutting plotters allow virtually anyone to quickly make and sell items, even if they are inferior quality, local markets have become increasingly saturated and competitive. Some homepreneurs view their competition positively, as "*something that forces [them] to be better*" (S40) and ensures that their "*projects are clearer and cleaner and professional looking than others*" (S45), however, many were irritated by how competitive local markets had become, noting "*it's the reality - everyone seems to have a Cricut these days*" (S17) and "*we've had lots of people pick up Cricuts in my area and then the next day open a business and push stuff out because they joined a group and saw others that make it look easy"* (I6).

Not everyone tries to stand out in these marketplaces, but if they do they use traditional marketing techniques such as discounts or giveaways tied to social media sharing to artificially create word-of-mouth advertising and grow their client bases [8, 23], e.g., "*I do a share with a friend to get an entry [into a draw] … ideally they bring like-minded friends who want the same décor*" (I2) or "*if I have a sale I offer a discount to people and encourage them to share the post*" (I7). Perhaps driven by desires to keep costs low or the lack of time they devote to updating social media (Fig. 5 bottom), rather than paying for advertising (22%), homepreneurs often use more organic, 'trustworthy' advertising methods, such as client reviews and word-of-mouth advertising (61%) because "*offering fair prices and friendly services goes a long way! I do not promote my business much, but I work based on referral*" (S17) and "*once one person gives away your item as a gift, word spreads, and that is how I get referrals*" (S31). Many also "*make sure [their] quality is the best it can be to stand out from others and keep coming up with fun designs*" (S43) or "*make barn board signs that cannot be copied or replicated, the styles and quality of [their] work are unique*" (I7). Because these homepreneurs have non-anonymous personal relationships with their clients, they perform long term emotional labor not only to increase the likelihood that they receive good reviews, but also to maintain the personal relationships they have cultivated with clients on the off chance they may lead to referrals. This differs from the short-term emotional labor performed by gig workers in that these homepreneurs have *many* interactions with a client over time and thus have *many* repeated opportunities to influence their opinions [129]. To maintain relationships with clients in these saturated markets, homepreneurs may thus have to exhibit more surface acting [92] than they may normally desire to do.

Because their local market is saturated, in addition to advertising, pricing becomes crucially important. Unlike classical gig economy workers on platforms like TaskRabbit or Uber, which

rely on algorithms to set prices [68, 69, 74], these homepreneurs set their own prices, but use a variety of strategies to do so. Thirty-nine percent of surveyed homepreneurs had developed their own formula to derive prices (e.g., *"material cost + $10-$20"* (S28), *"cost of materials x 3"* (S20), *"expenses + 25% time markup"* (S17)), whereas eighteen percent percent use a combination of competitors' pricing and their own costs (18%). Surprisingly, fourteen percent base prices on what they "*feel is a good price*" (S21), "*what would I pay for that*" (S48), or "*ask friends what they would pay*" (S25) and twenty-nine percent assign prices based solely on "*other sellers' average pricing for my area*" (S10), *"I match what others sell for so I'm not undercutting anyone*" (S16), "*what other items similar are selling for on Etsy"* (S31), and *"I look at Etsy and see what they sell for there and keep the cost the same, if not lower"* (S34). These market-based pricing strategies may result in attractive prices for clients, however, this local competition decreases the likelihood that a homepreneur is able to recuperate their time and material costs, which is similar to the situations that many global gig economy workers on platforms like Etsy find themselves in [76]. For those whose business is a hobby where some "profit" comes from client satisfaction, this may be acceptable, however, for those with necessity-based motivations such as health care expenses, these pricing practices may transform their efforts into a money-losing endeavor.

5.5.2 Bespoke Operational Practices. Social networking platforms and online communities enable homepreneurs to advertise and easily reach a local client base. The downside, however, is that homepreneurs have to develop cumbersome strategies and take unnecessary risks to overcome the lack of listing pages, analytics, order tracking, shipping integration, and credit card checkout that are not provided by these platforms. Because many homepreneurs do not use a selling platform with an order dashboard or centralized ordering system, they have implemented ad-hoc techniques to receive and track orders. Some use Facebook Messenger as a to-do list to sort and track inquires, e.g., "*I take orders through Facebook Messenger and when the order is done, I'll usually send them a picture … if they message me with an issue later, I'll have that same message thread and know what they've ordered and what it looks like when they got it*" (I8). For this homepreneur, Facebook Messenger acted as a communication medium, to-do list, and visual history record of the transaction. The images they provided the client of the final artifact made the client happy because they could see the final product before pickup, but it also served as a historical reminder of the state the client received the item in and helped the homepreneur identify potential reasons for client dissatisfaction in the future. Others ask clients who sent them inquires in channels other than email to resend them the same request through email using specific details so that the homepreneur can tag and search through orders in one channel, "*there's a lot of people that will message me on Facebook … and then it's like, well, can you email me what you want because then I can just tag it and rather than read through my page to track it … like the younger generation, they love texting and Facebook and social media but it makes it hard to have any type of order system*" (I1). Many homepreneurs also use physical notebooks or sheets of paper to record and organize orders and additionally create a digital spreadsheet for redundancy, e.g., "*I write orders down in a book first and then when I have time, I input that to the computer. This lets me make sure and double check, triple checked I've done at all. Sometimes when orders get crazy, it'll start slapping up eight by tens of paper all over my cabinet with painter's tape. But then immediately once it's died down and everyone's got their stuff, I transfer everything more permanently and the pages come off the wall.*" (I2). These ad-hoc

techniques keep homepreneurs organized but require extra effort to maintain across the multitude of digital and physical channels that homepreneurs use.

In addition to developing ad hoc strategies to receive and track orders, online communities such as Facebook do not support payment processing unless a 'shop' is created (and the platform takes a cut of their sales), so homepreneurs must manually create invoices, organize and receive deposits and payments, and generate receipts themselves. This differs from the features found within most social economy platforms, which by design accept payments from clients and forward a portion of them to a worker in a frictionless manner [35, 42, 59, 99]. Although the majority of homepreneurs accept payments through trackable digital platforms such as Square (20%), PayPal (16%), and eTransfers (i.e., a zero-cost funds transfer service between personal bank accounts in Canada; 86%), they also regularly accept cash as well (84%). Unless a homepreneur meets up or schedules the collection of deposits or full payments before starting an order, they could be out the cost of their materials and time if a client does not pick up an order, stops responding, or does not leave a payment at the time of pick up, e.g., "*In the past when I was doing the socks for charity I just posted on Facebook and took orders and requested payment at the end. Mistake. I had to chase people to pick up their order so I could get paid*" (S21), "*I now require payment in full on personalized items with someone's name, birthday, etc. because it's very hard to sell those types of items to someone else to recover my costs*" (S28), and "*I require people who have no-showed previously to pay for at least supplies before I start their order*" (S43). These "work then receive payment" strategies are risky because unlike the methods currently used within social economy platforms, there are no direct consequences for non-payment (e.g., no feedback or rating database of clients or banning them from a platform), homepreneurs have to set their own prices, and homepreneurs have little recourse if a transaction falls through or a client commits friendly fraud[3]. The independent nature of these homepreneurs currently opens them up to greater degrees of risk than other gig-type workers.

6 DISCUSSION

From highlighting the emotional benefits of running a home-based business to the challenges of competing in saturated markets, this exploration of at-home, personalization-based manufacturing has shed light on the opportunities, obstacles, implications, and practices of women homepreneurs who use social networking platforms to sell goods made with cutting plotters. Next, is a discussion of how these technologies have enabled a new generation of mompreneurs to thrive, the benefits of using Facebook as a scaffold to run one's business, the challenges inherent in identity management when one's online business and personal identities are combined, and the technological challenges and barriers that must be overcome to help streamline homepreneurs' and content creators' workflows.

6.1 Emergence of the Next Generation of Mompreneurs

Interestingly, the surveyed population of homepreneurs was largely composed of mothers or grandmothers (69%) with tertiary educations (78%). These "mompreneurs" are highly educated and were found to balance their business activities with childcare responsibilities, largely to

[3] Friendly Fraud (en.wikipedia.org/wiki/Chargeback_fraud): "Chargeback fraud, also known as friendly fraud, occurs when a consumer makes an online shopping purchase with their own credit card and then requests a chargeback from the issuing bank after receiving the purchased goods or services."

earn additional income for their families. The trend for mothers to run home-based businesses is not new. From as early as the 1900's, Madam C. J. Walker employed mothers as consultants to sell hair treatments and cosmetics as part of her multi-level-marketing business [72, 109]. Unlike other multi-level-marketing consultants, e.g., Tupperware, Avon, Mary Kay, LuLaRoe, or Scentsy, these mompreneurs do not purchase startup goods from a parent company, need to meet monthly sales quotas, or recruit others to sell for the parent company. Once they acquire their plotter and materials (from any number of sources), they choose what services to offer, goods to make, and when, thereby creating new opportunities for autonomy and flexibility. This thus makes them more akin to gig workers on platforms such as Etsy or Fiverr [32, 58, 60, 76, 85, 90] than multi-level-marketing consultants.

This new generation of "mompreneur manufacturing" has been enabled by the technological deskilling that desktop cutting plotters support, the online repositories of designs that can be purchased, and the tracing functionality found within plotting software that allows for design appropriation. Thus, mompreneurs do not need graphic design or technical training to use cutting plotters or make eye-catching professional designs or goods. Unlike other DIY or making activities, they also do not need to travel a dedicated location like a makerspace or library or have a special room for their plotter [96, 98, 130]. They can create or appropriate existing designs on a tablet or laptop while sitting on their couch, caring for their children, and then cut materials and assemble goods on their kitchen tables. The confluence of these hardware and software innovations has enabled cutting plotters to become the first truly accessible, mainstream personal fabrication platform.

Simultaneously, mompreneurs' use of social networking groups has enabled them to access a growing marketplace, often composed of other mothers, to sell goods and market their personalization services. Similar to Moser et al.'s analysis of mothers' abilities to buy and sell goods in local Facebook groups without the need to create a website or online store [97], mompreneurs can quickly take pictures of new designs or create mockups of goods on their mobile phones, post them to local groups or marketplaces that have vast networks of potential clients, and immediately start taking orders and generating revenue. This allows them to spend less time on "business requirements" and more time being creative [76]. These groups also have the added benefit of providing homepreneurs with an anonymous method to access local pricing and product ideas right from their homes, negating the need for them to do extensive research to understand their competition. The frictionless access to potential clients that these online social platforms provide ensures that mompreneurs to have unprecedented flexibility and control over their business and thus success as a digital economy entrepreneur.

These freedoms do, however, come with costs. As many homepreneurs noted, and has been found with many gig economy workers [32, 35], it is challenging to maintain an equilibrium between one's business activities and home life. Because many homepreneurs have co-opted communal family spaces for business activities, it can be hard for homepreneurs to stop working, or let go of feelings to "*just let me do one more order*" (I2). Instead of being able to go home to a place of refuge after a day of driving or shopping for others, their homes have become their workplaces and are filled with constant, continual reminders that there are orders to complete and customers to reply to. Although none of the interviewed homepreneurs made enough money to live solely off of their business activities, as each homepreneur's business grows, they will have to spend more time creating new products and finishing commissioned designs, take on more blank inventory, and exert more effort to respond to customer inquiries

and complete co-design cycles. It thus seems as if these homepreneurs will eventually find themselves at a crossroads where they will need to decide if the effort they put into their "hobby" or "part-time job" is truly worth the returns they reap from it.

6.2 Facebook as a Scaffold

Although many entrepreneurs use Facebook as a social media platform to grow and connect with their client base and other entrepreneurs [24, 43, 63, 108], those within the crafting homepreneur community use it for much more. Homepreneurs currently rely on a patchwork of physical organizational strategies and software applications for the creative side of their business, however, Facebook has become a great scaffold and valuable sandbox within which anyone can learn how to run an online business in the digital economy. Not only can potential entrepreneurs quickly attract clients via local buy-and-sell groups or the Facebook Marketplace, as demonstrated by Moser et al. [97], but they can also can advertise and find clients by posting pictures to a Facebook business page right from their mobile phone, take orders and respond to inquiries through Facebook Messenger and tagged posts, order materials through buy-in groups, and build trust with clients using a single online identity for their business and personal life. As they work from home, Facebook can also acts as gateway to the larger global community of other homepreneurs who encounter the same technical, business, and emotional challenges that they do, much like having access to a global water cooler or support system. Even if the majority of potential entrepreneurs lurk rather than actively contribute to the community, they can still find technical assistance or help in (plotter-specific) groups, keep tabs on their competitors, and get ideas for new designs, goods, and pricing via business pages or posts.

Maintaining active social media channels is essential for any online business [43, 46] and many social media platforms including Facebook provide analytics and dashboards that summarize viewership and engagement demographics to help with the targeting of content. However, many homepreneurs (and likely other entrepreneurs) have a difficult time identifying where, when, and what content to post in a given channel. As stated by two interviewed homepreneurs, "*I haven't done a lot with the Instagram thing because then it's okay, well this goes on my personal account, this goes on my business, this goes here, oh wait, no that goes there kind of thing ... so then it's kind of overwhelming because there's so many different places you could post things and you have to do each one separately*" (I8) and "*honestly it would take me a week of doing nothing else but trying to figure it all out ... I would almost have to hire someone to do it in the background for me*" (I7). While awareness about these features may be the fault of individual platforms themselves, their lack of use suggests that there is a need to better identify and understand the specific elements and barriers that prevent them from being used. As surveyed and interviewed homepreneurs did not report doing any market research to better understand their customer base, there seem to be ample opportunities to use these dashboards to scaffold homepreneurs' and all business owners' knowledge of advertising to their client bases and develop user interface elements for posting content that integrate analytics.

The access to detailed information and examples of successful selling practices that can be found in Facebook groups cannot be found when using personal websites on platforms such as Shopify or Squarespace because these other platforms do not extend access to networks of potential clients and resource streams, allow for complete worker flexibility, help build trust with clients, or facilitate connectivity with the larger cutting plotter community [125]. Therefore, Facebook is an incredibly useful springboard when one is first starting their business. However, the role of Facebook does change over time as the capabilities of Facebook become

insufficient for the demands of one's business, the presence of local competition increases, and there is an increased propensity for intellectual property appropriation of ideas and graphics. Eventually, homepreneurs will need to "graduate" to more mature platforms that offer functionality such as transaction management or more direct match-making opportunities between themselves and potential clients [125].

Although Facebook provides many with quick access to a local market and frictionless advertising opportunities, homepreneurs' use of Facebook echoes the current challenges found with algorithms that assign tasks in the gig economy. Because these workers depend on the single platform of Facebook and the policies and decisions Facebook makes are non-transparent and frequently change, as noted by Sutherland and Jarrahi [124], there is a degree of inequality between the worker (i.e., homepreneur) and the platform (i.e., Facebook). While this inequality does not currently dictate who can participate in this specific digital economy or algorithmically limit one's opportunities to take on orders, changes to feed algorithms or recommended groups or posts could severely limit the current flexibility and agency held by those who use Facebook. Facebook also currently allows homepreneurs and content creators to 'advertise' goods on their pages and in groups via posts for free, however, Facebook could change these policies and require portions of the sales initiated or made on their platform to be remitted back to them. Some individuals may be ok or able to give a portion of their profits to Facebook, similar to how workers on Uber, TaskRabbit, and Fiverr do, however, others operating on thin margins may not. Some individuals may thus be forced to transition to other free services or build their own website or open their own store on Etsy to regain autonomy and control.

6.3 Shared Personal and Business Identities

While Facebook may be a convenient, free "one stop shop" for many homepreneurs, there are numerous advantages and implications of depending on one platform or channel to run a business and having that platform be tied to their personal identity. Because many homepreneurs use one Facebook account for both personal and business activities, they can dually purpose the content they share online with clients. This can help them build trust by demonstrating that they are a real person who actually lives in the local area and has a family and hobbies and interests. For those who live in rural areas or small towns, this can be additionally useful because potential customers can look through their list of friends and, if they know someone in common, ask that person about the homepreneur or to see something they have made. As many homepreneurs and content creators use business names that are unaffiliated with their actual name, having a digital link between one's business page and personal Facebook profile also helps clients discover and search for a homepreneur, especially if a client is referred by someone else, e.g., "*if my clients can't remember my business name, they can search for my actual name on Facebook and find the link to my business right on my profile*" (I5). These opportunities are not currently afforded by other types of social economy platforms due to their anonymous nature and the user interface designs that present only a subset of potential gigs to choose from [68, 69, 74]. While some gig workers may desire for more information about themselves or their skills be shared on social economy platforms, it is unclear if this is an avenue that platform developers should support and facilitate in the future.

There are, of course, detrimental effects to having one fused identify on the only platform that you use to sell goods. If a homepreneur was hacked or locked out from Facebook, for example, they would lose their client base, order tracking system, advertising streams, and

suppliers, i.e., their entire business. They would then have to sign up under a new account and begin their business from scratch. The use of one's personal identity and word-of-mouth reputation to build trust in lieu of a verified feedback system such as those found on shared economy platforms such as Uber, Airbnb, Etsy, or Fiverr, however, can be detrimental if one's personal behavior influences their business. For example, if a homepreneur is removed from a buy and sell group for violating the rules, then they would lose access to that potential network of clients, revenue stream, and the ability to gauge and appropriately price their goods to compete within their local market. Alternatively, if potential clients view content or opinions that are posted by a homepreneur or content creator or view the list of (controversial) groups they belong to, clients may form biases or opinions about the homepreneur based on the lifestyle, gender, geographic location, mental health, socio-economic status, or so on that are depicted. This practice has unfortunately been found to be prevalent and a detractor of revenue on platforms such as Fiverr and TaskRabbit [58, 71]. The ability for customers to view such information could unintentionally alienate an entire subsection of a homepreneur's potential client base. While Facebook users can set certain aspects of their profiles to be private, prior research has found these settings to only match user expectations thirty-seven percent of the time [86]. As is commonly done on reddit and Instagram, it thus may be worthwhile for some business-focused Facebook users to create semi-anonymous throwaway [45] or fake 'finsta' accounts [33] so that they can maintain a proxy of authenticity to their real lives while ensuring their privacy. It would also be beneficial for platforms themselves to offer all homepreneurs, social media managers, public relations professionals, and business owners enhanced posting tools, feedback, and perhaps different user interface designs, so that they too can better manage their multiple online identities.

6.4 Streamlining At-Home, Personalized Manufacturing

The flexible, personalized manufacturing processes homepreneurs use enable them to eliminate many of the challenges encountered while running more traditional businesses, in that they can work with different materials, blank goods, equipment, and techniques on-demand and offer a wide variety of goods that cater to underserved, small, or ignored communities [6, 83]. These processes also allow homepreneurs to quickly adapt to changes in the market and seasonal demands and allow for short product life cycles and small client orders. Although there are forecasts predicting that mass personalization will become a software service [103], the interactions between the producers and consumers and producers and their goods are crucial and cannot be ignored [59]. While some homepreneurs or manufacturers may appreciate the increase in orders and subsequent income that could result from converting their business into a distributed manufacturing service like those on 3DHubs[4] or 100KGarages[5], they would not be able to reap the emotional benefits that they currently attain when working with a client in a co-design relationship to make their design ideas a reality. The direct communication and co-design processes that homepreneurs and clients use provide a sense of agency, ownership, and personal fulfillment that cannot be found when one is strictly a drop shipper or fulfillment center.

To maintain the motivations and benefits of at-home, personalized manufacturing but ensure that the time devoted to these businesses is manageable, all homepreneurs will continue to need

4 www.3dhubs.com
5 100kgarages.com

more streamlined e-commerce tools. Facebook does offer tight integration with Shopify, enabling Shopify store owners to utilize Shopify e-commerce functionality such as managing transactions, allowing for shopping and checkout through Facebook, and enabling clients to send requests and communicate through Facebook Messenger. It remains to be seen, however, if platforms such as Facebook should continue to integrate these missing e-commerce and social economy features into their platform (which would thus complicate Facebook usage for homepreneurs and potential clients further), if homepreneurs should disentangle their business activities from Facebook and migrate towards e-commerce platforms, or if a new category of platforms that fuse social networking and social economy functionality should emerge.

In addition to streamlining e-commerce platforms, the complex software mashups and mobile tool chains that homepreneurs use to create cuttable designs and advertising images or mockups are cumbersome and time consuming. Although some of the software mashups are utilized because homepreneurs do not take the time to learn how to use an all-in-one program such as Adobe Photoshop or cannot afford the program, others are the result of the intellectual property protection challenges that many content creators currently face. Content creators currently add watermarks or their business name to their images using mobile applications specifically designed to support this functionality such as eZy Watermark or iWatermark. These applications allow one to add "beautified" watermarks to an image or batch of images using a variety of pre-made templates. While some content creators could likely recreate the same watermark in another graphic editing application they are already using, it is much faster and easier to select a template and apply it to a batch of images. As anyone who posts product images online to promote their brand and goods must also go through this process as well, it is understandable why such mobile tools exist. Their very existence speaks to the need for more flexible, free software that can perform multiple "business critical" tasks.

As highlighted in the findings, many homepreneurs currently use social media groups on Facebook to search for help rather than post content due to concerns over appropriation. The appropriation of community content from these groups, in addition to licensed and third-party content, is a practice partaken by many and will likely continue to be encouraged by plotter companies because they want to ensure that their software supports users with almost no graphic design skills in creating professional looking designs. From the perspective of content authors, however, there is a justifiable need for appropriation preventing tools or file protections aside from watermarks so that rather than "giving" away their content as they do now, they can "share" or provide "temporary access" to it [137]. Mobile phone apps that can create short 3D gifs or animations of digital mockups may be useful, especially if clients must view the mockup in an app where taking screenshots is disabled (as is currently possible on Android phones). Such media would offer clients the ability to see a full 3D rendering of the good and design they will be purchasing while ensuring that a content author's design is protected. The ability to post limited-view, self-destructing images or videos in public forums or send them to clients could also help appropriation concerns. Ephemeral media such as Snapchat Snaps naturally encourage the limited sharing, but not appropriation, of content. If one had confidence that their publicly posted photo would fade or decay over time and thus could not be copied, as proposed by Gulotta et al. [55], then perhaps seasoned content creators would post more content and share more failures and successes within Facebook groups. One could also imagine homepreneur's leveraging current mobile app models and putting mockups behind paywalls that only allow a limited number of viewings [137]. Using such a technique would

enable a content creator to be paid a small amount for the viewing, or later usage, of their designs, perhaps removing some of the negative feelings associated with the current appropriation of their intellectual property. This could also reduce the number of co-design clients who ask for repeated changes to a mockup, thus saving a content creator or homepreneur time and effort.

Lastly, there is a need to streamline the learning and extensions of skills obtained while using equipment such as cutting plotters. There has been research within the fabrication community to decrease learning curves with 3D printers and other fabrication machines by specifying input to a machine using techniques that offer visual feedback [100], intelligently assisting with common tasks such as measuring [74], or guiding users via haptic feedback towards their intended design [141], that can be applied to this community as well. However, there are still many unique challenges that remain. Some users may benefit from adaptive software tutorials or applications that track and identify their frequently performed tasks and identify new features or tools for them to learn [25], whereas others may benefit from tools and media that offer real-time, on-demand assistance from experts, such as livestreams with homepreneurs who are in other locations to alleviate concerns about local competition [44]. Integrating some aspects of social media platforms within design software such as text-only summaries of answers to Facebook questions could enable users to easily search for help and annotate answers for future use. In addition, it may be beneficial to include to screen capture functionality that intelligently obfuscates the design one is working on so that a content creator can ask for contextual-based assistance from others while also protecting the designs they are working on.

Although only a handful of homepreneurs felt as if they, and their market, have already outgrown their desktop cutting plotter, it is natural that they would want to expand to other manufacturing techniques and tools (e.g., *"We're investing in a Glowforge laser engraver because I want to go to markets and go, "Hey, do you want your cellphone case engraved?" because the market's saturated with people who have the 12 inch wide vinyl cutters"* (I6)). As there is a natural trajectory to transition from the 2D vector graphics needed for 2D cutting plotters, laser cutters, and engravers to the 3D models required for 2.5D CNC routers and 3D printers, there will be an increased need for software learning methodologies and techniques that ease this transition. In addition to assisting users in understanding the theoretical underpinnings and limitations of these higher dimensional spaces and the navigation and manipulation techniques employed within them (e.g., the need for support structures when printing in 3D and the use of extrusion functions), it is imperative that design applications support users in identifying the appropriate manufacturing techniques and materials needed to fulfill a given client request. Having access to intelligent, geometric machine learning systems that can help users decompose a 3D client design or inspirational artifact into manufacturable steps will be of great benefit to all personal fabrication communities. In addition, the development of algorithms that can transform 3D designs to 2D or 2D designs to 3D will allow for the reuse of one's own designs across different fabrication platforms, thereby decreasing the learning curves that are often encountered when using 3D environments. While solutions to these challenges would help homepreneurs themselves, they would also be of great to benefit those learning to 3D print or teaching others how to use fabrication equipment, those developing 2.5D and 3D fabrication software and tutorial systems, and other DIYers and makers who are remixing open source content found online.

6.5 Limitations

Although this research uncovered many novel insights, opportunities, challenges, and implications of using personal fabrication equipment and social media platforms for homepreneurship, it is not without limitations. The lack of men within the survey population, is, of course, a limitation, in that the results cannot be generalized to the entire population of possible homepreneurs or enable for commentary on potential gendered differences in terms of the activities performed [5] or income generated [27, 42, 58, 71]. While this is a limitation, the survey population does representation current trends relating to cutting plotter usage. Both Silhouette America (makers of the Silhouette line of cutting plotters) and Provo Craft & Novelty (makers of the Cricut line of cutting plotters) sell cutting plotters at craft stores and market plotters towards crafters, of which seventy-two percent are women [28, 36]. Women are also twice as likely to use cutting plotters in makerspaces than men [134]. Pinterest, which ninety percent of respondents reported using to gather design ideas, also has a user base comprised of seventy percent women [112]. Future research should recruit and explore other gender and age populations who take part in these activities and also understand the roadblocks that may prevent them from doing so.

The choice to recruit participants from Facebook and then find that most respondents use different facets of Facebook to run their businesses is also a limitation of this research. Within North America, Facebook is a dominant social media platform, especially amongst mothers [97] so it makes sense that this population would gravitate towards Facebook to run their businesses because it is already engrained in their day to day lives. In addition, neither Provo Craft & Novelty nor Silhouette America run online group or support forums, however, both companies, have active social media accounts on Facebook that are frequently updated with news, tips, free design downloads, and contests. These offers naturally draw newcomers to these pages and thus Facebook as a whole. It would, however, be beneficial to contrast these Facebook-centric findings to populations of users who employ personal fabrication machines but do not use social networks for selling, such as those on platforms such as Etsy, Shopify, or Squarespace.

Lastly, this research focused on the use of one type of personal fabrication machine in one specific context, i.e., cutting plotters in Canada. However, the survey and interview findings about the appropriation of intellectual property on social media platforms, the fusion of home and work spheres, and the use of buy-in groups to acquire supplies are complementary to findings about entrepreneurs in Sweden [108], farm life in USA [79], and weaving practices in Malaysia [138, 139], respectively. Thus, it is anticipated that many findings may be generalizable to other countries and contexts. Future research, however, should explore the other communities that participate in homepreneurship activities such as those employing other emerging personal fabrication technologies and those in different geographical contexts.

7 CONCLUSION

The continued ubiquity and decreased cost of personal fabrication equipment has enabled many to enhance traditional handiwork practices and processes with technology. Simultaneously, the reach and growing pervasiveness of social networking platforms has enabled those with entrepreneurial goals to have access to, and cultivate, growing client bases. Nowhere have the opportunities afforded by the fusion of personal fabrication and social networking been more visibly prevalent than within the crafting community.

As this work has demonstrated, a growing population of crafters have begun using low-cost desktop cutting plotters to start businesses that create bespoke, personalized goods for others.

Through interview and survey data with Canadians who are part of this community, this work uncovered a growing subset of homepreneurs, i.e., mompreneurs, that balance childcare or full-time jobs with their business activities using conjoined spaces in their homes. The data underscored the complex software tool chains that these deskilled users have developed to create personalized deigns and graphics for their business and the challenges that arise when these safe, portable, and easy to use personal fabrication machines are used at home for entrepreneurial purposes. Interestingly, Facebook was also found to act as a scaffold to the digital economy for these homepreneurs through its frictionless ability to support the finding of local clients, gathering of ideas for goods, co-working on orders with clients, searching for help, researching one's competition, and the acquisition of materials. The downside of using such platforms, however, was that homepreneurs often fused their personal and business lives online, resulting in challenges with identity management. Fueled by the saturated completion within homepreneurs' local areas and the functionality found in cutting plotter software, the appropriation of other's intellectual property was also found to be a rampant and significant practice and challenge within this community.

By identifying the obstacles these homepreneurs face when using fabrication machines such as cutting plotters, the implications of using social media to spur local sales, and the lifestyle influences of their workflows, this research has demonstrated the opportunities that the fusion of personal fabrication, social media, and e-commerce have provided to a growing community of crafters. As the frontier of personal fabrication technologies and equipment continues to expand, equipment becomes more inexpensive and attainable, and the community and their activities become more diverse, there will be an increased need to further understand and develop solutions to the opportunities and challenges that these homepreneurs and other content creators will face.

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Appendix A: Survey Questionnaire

Note that all questions required answers and questions with an * were open-ended.

1. What is your age? *
2. What is your gender? *
3. Are you a parent with children under the age of 18 that live (either part time or full time) in the same home as you?
   a. Yes
   b. No
4. Do you have any post-secondary training (e.g., diploma, degree, certification, etc.)? If you do, what training do you have and in what discipline? Note that it does not have to be related to using your machine. *
5. My small business or home business is: (Select all that apply)
   a. My hobby
   b. A part-time job
   c. A full-time job
   d. Other
6. What do you use your cutting machine for? *
7. What motivates you to do what you do with your cutting machine? *
8. Have you sold five or more items you made with your cutting machine in the last two months to customers who were not friends or family?
   a. Yes
   b. No
9. Which cutting machine(s) do you have? (Select all that apply)
   a. Brother Scan and Cut 1
   b. Brother Scan and Cut 2 CM 350W
   c. Brother Scan and Cut 2 CM 650W
   d. Original Cricut
   e. Cricut Expression
   f. Cricut Imagine
   g. Cricut Expression 2
   h. Cricut Mini
   i. Cricut Cake
   j. Cricut Maker
   k. Cricut Explore 1
   l. Cricut Explore Air
   m. Cricut Explore Air 2
   n. KNK Zing Orbit
   o. KNK Maxx Air
   p. Janome Artistic Edge
   q. Graphtec (any model)
   r. Roland Stika
   s. Roland GS-24 CAMM-1
   t. Silhouette Portrait
   u. Silhouette Portrait 2
   v. Silhouette Cameo 1
   w. Silhouette Cameo 2
   x. Silhouette Cameo 3
   y. Silhouette Curio
   z. US Cutter (any model)

aa. Other (please specify)
10. Why did you acquire the cutting machine(s) you have? *
11. How many years have you used cutting machine(s)? *
12. How often do you use your cutting machine(s)?
    a. Every day
    b. A few times a week
    c. Once a week
    d. A few times a month
    e. Once a month
    f. Less than once a month
    g. Once a year
    h. Less than once a year
13. What do you make with your cutting machine(s)? (Select all that apply)
    a. Personalized drinkware, foodware, or glassware (e.g., tumblers, mugs, glasses, wine glasses, plates, bowls, etc.)–Decals for laptops, walls, front doors, windows, or vehicles
    b. Labels (e.g., spices, storage containers, craft supplies, etc.)
    c. Personalized clothing (e.g., t-shirts, jerseys, jackets, sweatpants, swimsuits, pajamas, bridal robes, baby onesies, baby bibs, etc.)
    d. Personalized designs for fabrics that are not clothing (e.g., drink koozies, freezie holders, tooth fairy bags, tic tac toe sets, blankets, pillows, purses, cosmetic bags, camping chairs, flags, flip flops, etc.)
    e. Seasonal fabric items (e.g., Christmas stockings, Christmas tree skirts, Christmas sacks, Easter baskets, Halloween buckets, etc.)
    f. Non-fabric seasonal items (e.g., yardzee, light up camping buckets, outdoor planters, Christmas ornaments, etc.)
    g. Personalized baubles (e.g., keychains, sunglasses, door hangers, etc.)
    h. Personalized stuffed animals
    i. Wood signs
    j. Etched mirrors, lanterns, or glassware (or similar)
    k. Decorative mirrors, tiles, or lanterns (or similar)
    l. Cake or cupcake toppers (or similar)
    m. Paper flowers
    n. Wedding decor (that is not paper flowers) or wedding favors
    o. 3D or Geometric paper sculptures
    p. Scrapbook pages
    q. Cards or invitations (or similar)
    r. Art
    s. Jewelry (e.g., bracelets, earrings, necklaces, etc.)
    t. Bows / headbands
    u. I make designs for others to use on their machines
    v. Other (please specify)
14. Who do you make items for? (Select all that apply)
    a. Myself
    b. My friends and family
    c. My co-workers
    d. My employer
    e. Individual clients local to my city or town
    f. Individual clients in different cities or towns in my province
    g. Individual clients in different cities or towns in Canada
    h. Individual clients in different countries (e.g., USA, Australia, UK, Mexico, etc.)
    i. Other small businesses
    j. Corporate clients

   k. Wholesalers
   l. Other (please specify)
15. What materials do you cut with your cutting machine(s)? (Select all that apply)
   a. Paper (e.g., cardstock, chipboard, kraft, construction, corrugated, foil transfer, vellum, score & emboss, parchment, wrapping, sticker, etc.)
   b. Photo paper or film
   c. Magnet paper or film
   d. Tattoo paper or film
   e. Image transfer paper or film or waterside paper or film
   f. Sublimation paper or film
   g. Foam
   h. Fabric (e.g., cotton, polyester, spandex, leather, canvas, felt, denim, suede, burlap, etc.)
   i. Removable adhesive vinyl (e.g., solid, patterned, printable, specialty, etc.)
   j. Permanent adhesive vinyl (e.g., solid, patterned, printable, specialty, etc.)
   k. Adhesives (e.g., Washi tape, duct tape, double-sided adhesive, etc.)
   l. Heat transfer vinyl (e.g., solid, patterned, printable, specialty, etc.)
   m. Stencil vinyl or film
   n. Silkscreen material
   o. Cardboard
   p. Wood (e.g., balsa, basswood, etc.)
   q. Plastic (e.g., shrinky dinks, acetate, projection film, etc.)
   r. Metal (i.e., for stippling / etching)
   s. Cork
   t. Fondant / icing sheets
   u. Window cling film
   v. Other (please specify)
16. Where have, did, or do you get the materials that you put into your cutting machine(s) from? (Select all that apply)
   a. The manufacturer of the vinyl (e.g., direct from the Orafol, Avery, 3M, Siser, or FDC, etc. factory)
   b. A general-purpose store (e.g., Walmart, Superstore, Dollarama, etc.)
   c. A craft store (e.g., Michaels, Deserres, etc.)
   d. A craft vinyl business (e.g., Script Designs, Blue Sapphire, etc.)
   e. A sign shop or vinyl business (e.g., Sign Supply, ND Graphics, Grimco, Ink4u, etc.)
   f. A buy-in group
   g. A Facebook group
   h. An online marketplace in Canada or the USA (e.g., Amazon, eBay, Etsy, etc.)
   i. An online marketplace in another country (e.g., Aliexpress, Wish, DHgate, etc.)
   j. Other (please specify)
17. What other materials do you use to make your items (e.g., glitter, wood, paint, adhesives, blank tumblers or clothing, etc.)? *
18. What is the most frustrating aspect of working with materials that require a cutting machine to cut, modify, or manipulate them? *
19. What other equipment or personal fabrication technologies do you use to make your items? (Select all that apply)
   a. None
   b. Heat press
   c. Cricut Easy Press
   d. Iron
   e. Light pad (e.g., Cricut, self-made, etc.)
   f. General purpose printer (e.g., Canon, HP, Brother, etc.)

g. Sublimation printer
h. Tumbler rotisserie turner (e.g., We R Memory Keepers Spin It, self-made, etc.)
i. 3D printer (e.g., Makerbot, Silhouette Alta, Dremel Digilab, etc.)
j. Laser cutter (e.g., FSL, Epilog, Dremel, etc.)
k. CNC router (e.g., Shapeoko, X-Carve, etc.)
l. Stamp making machine (e.g., Silhouette Mint)
m. Embossing / dye cutting machine (e.g., Sizzix Big Shot, Spellbinders, Gemini, Cricut Cuttlebug, etc.)
n. Sewing or embroidery machine
o. Digital camera or cell phone camera
p. Light hand tools (e.g., squeegee, tweezers, weeding pick, weeding ring, etc.)
q. Manual tools (e.g., saw, hand sander, screwdriver, hammer, plane, etc.)
r. Power tools (e.g., drill, miter saw, orbital sander, dremel rotary tool, jigsaw, scroll saw, etc.)
s. Other (please specify)

20. Why don't you use other personal fabrication technology to make your items (e.g., 3D printer, laser cutter, CNC router, etc.)? (Select all that apply)
    a. I already use other personal fabrication technologies to make my items
    b. I don't know what they are
    c. I don't know what I would use them for
    d. I don't have the time to learn how to use new equipment
    e. They cost too much money
    f. The materials are too expensive
    g. I don't have the space
    h. I am worried about the health and safety effects of using them
    i. Other (please specify)
21. Thinking back over the last two months, what has been your favourite item to make (regardless of if it sold or not)? Why? *
22. Where do you get your design ideas from? (Select all that apply)
    a. Pinterest
    b. Instagram
    c. Clients
    d. Etsy
    e. Machine manufacturer websites (e.g., Silhouette: silhouette101.com, Circut: inspiration.cricut.com, etc.)
    f. Machine manufacturer online stores (e.g., Silhouette Design Store, Cricut Access, etc.)
    g. Brand websites (e.g., Martha Stewart, Vickie Howell, Heidi Swapp, Tim Holtz, etc.)
    h. Websites not run by the machine manufacturer or a brand (e.g., silhouetteschoolblog.com, heyletsmakestuff.com, jennifermaker.com, etc.)
    i. Online portfolios or tutorial websites (e.g., Instructables, Behance, etc.)
    j. Facebook groups
    k. Books or magazines
    l. Items I see in brick and mortar stores
    m. Items I see in online stores
    n. Other small businesses
    o. Other (please specify)
23. Where do you get the graphics and fonts used in your designs? (Select all that apply)
    a. I design them myself
    b. I get them from my clients in editable formats (e.g., .svg, .studio3, .dxf, .ai, .eps, .cdr, etc.)
    c. I get them from my clients and use the trace function (or similar) in my cutting machine software to edit them
    d. I buy them from Cricut Access, Silhouette Design Store, etc.
    e. I buy them from a designer on Etsy, the designer's personal website, etc.

f. I buy them from a 3rd party website (e.g., DaFont, Creative Fabrica, DesignBundles, FontBundles, etc.)
g. I use free designs I find online (e.g., Google Images, Pinterest) in editable formats (e.g., .svg, .studio3, .dxf, .ai, .eps, .cdr, etc.)
h. I use free designs I find online (e.g., Google Images, Pinterest) and use the trace function (or similar) in my cutting machine software to edit them
i. I use free designs from a designer's personal website
j. I use free designs from a 3rd party website (e.g., DaFont, Creative Fabrica, DesignBundles, FontBundles, etc.)
k. I use open source designs I find online
l. I use the designs that came with my cutting machine's software
m. I use the designs that came with my computer
n. Cricut Cartridges
o. Other (please specify)

24. Do you buy commercial licenses for the designs you use?
    a. Yes, for each and every design I use–
    b. Sometimes for designs I use frequently
    c. No, I never do
    d. No, I make my own designs
    e. No, I use the designs that are free for commercial use or are open source
25. Do you make replica items that have licensed characters, sports teams, brand logos, TV show content, movie quotes or images, or music lyrics on them (e.g., Victoria's Secret logo, Toronto Blue Jays logo, Starbucks logo, etc.)? Why or why not? *
26. How did you learn to use your cutting machine(s)? (Select all that apply)
    a. Watched YouTube or Vimeo (or similar) videos
    b. Read tutorials or blog posts online
    c. Trial and error
    d. Watched a livestream on Facebook, Instagram, TikTok (or similar)
    e. Participated in a Skype call, Facetime call, or Google Hangout (or similar)
    f. Had a person in the same room as me show me (e.g., a teacher, friend, family member, co-worker, etc.)
    g. Went to a class or workshop
    h. Other (please specify)
27. Where do you learn about new skills, processes, or techniques to make items using your cutting machine(s)? (Select all that apply)
    a. Pinterest
    b. Instagram
    c. YouTube or Vimeo (or similar) videos
    d. Cutting machine manufacturer websites (e.g., Silhouette: silhouette101.com, Cricut: inspiration.cricut.com, etc.)
    e. Cutting machine manufacturer Facebook pages
    f. Websites not run by the cutting machine manufacturer (e.g., silhouetteschoolblog.com, heyletsmakestuff.com, jennifermaker.com, etc.)
    g. Facebook pages not run by the cutting machine manufacturer
    h. Brand websites (e.g., Martha Stewart, Vickie Howell, Heidi Swapp, Tim Holtz, etc.)
    i. Online portfolios or tutorial websites (e.g., Instructables, Behance, etc.)
    j. Facebook groups
    k. Clients
    l. Friends, family, or co-workers
    m. Classes or workshops

n. Books or magazines
o. Other (please specify)

28. What is the most frequent problem you have with your cutting machine(s) or their software? *
29. What is the biggest limitation of your cutting machine(s) or their software? *
30. How do you deal with competition from others who also sell items made using cutting machines? *
31. Have other people taken your ideas, designs, or photos and used them for themselves? What did you do about this? *
32. Have clients asked you to make items that use designs from other small businesses or big box stores? If they have, what did you do? *
33. When and why did you start your business? *
34. Who is part of your business?
    a. I run my business by myself
    b. My children, spouse, or friends help me out from time to time
    c. I help out my children, spouse, or friends with their business
    d. I have part-time paid employees
    e. I have full-time paid employees
    f. Other (please specify)
35. What percentage of the items that you make do you sell (rather than keep for yourself, gift to others, or donate)? *
36. Where do you sell your finished items? (Select all that apply)
    a. On my own website powered by Shopify, WooCommerce, Squarespace, Big Cartel, Zibbet, etc.
    b. On an online marketplace (e.g., Etsy, Kijiji, DaWanda, Store Envy, Aftcra, etc.)
    c. On an auction website (e.g., Bonanza, eBay, etc.)
    d. On my own Facebook page
    e. In a Facebook group I run
    f. In a Facebook group I don't run (e.g., a local Buy and Sell group)
    g. In a Facebook marketplace
    h. On Handmade at Amazon
    i. On Amazon.ca or Amazon.com
    j. On Instagram
    k. On social media platforms that are not Instagram or Facebook (e.g., Twitter, Snapchat, etc.)–
    l. On text-based platforms (e.g., iMessage, WhatsApp, etc.)
    m. On live-streaming platforms (e.g., Twitch, Tiktok)
    n. At craft fairs or community events
    o. In a brick and mortar store I own
    p. In a brick and mortar store someone else owns
    q. Other (please specify)
37. How do you determine the prices for your products? *
38. How do clients pay you for your items? Why do you have this payment policy? *
39. How are your items delivered to clients? (Select all that apply)
    a. Clients come to my house to pick them up
    b. Clients come to my full-time job to pick them up
    c. I drop them off at a client's home, business, or employer
    d. I meet the client in a public place
    e. By a shipping or freight company (e.g., Canada Post, UPS, FedEx, CanPar, Purolator, DHL)
    f. Other (please specify)
40. Where do you advertise your business or items? (Select all that apply)
    a. I don't advertise
    b. Online with Google Ads, Microsoft Advertising, or similar
    c. On Facebook with Facebook ads
    d. Online marketplace or auction websites via promoted posts or listings (e.g., eBay, Etsy, Kijiji, etc.)

e. On my website or blog
f. My Facebook page
g. In the Facebook group I run for my business
h. In Facebook groups I don't run
i. Using social media that is not Facebook (e.g., Instagram, Twitter, Snapchat)
j. On livestreaming platforms (e.g., Twitch, TikTok, etc.)
k. On video sharing websites (e.g., YouTube, Vimeo, etc.)
l. My clients advertise for me
m. Other (please specify)

41. Where do you get the images you use to show the items you can make? (Select all that apply)
    a. I take or make them myself
    b. I use images I find online
    c. I buy pre-made mock-up images and edit them
    d. I use the images from the manufacturer, distributor, reseller, or business I buy my supplies from
    e. I use images from other small businesses
    f. Other (please specify)
42. How much time do you spend ... (Options: I Do Not Do This Activity, Less Than an Hour, About an Hour, Between 1-2 Hours, Between 2-5 Hours, Between 5-10 Hours, Between 10-20 Hours, More Than 20 Hours)
    a. Acquiring materials or supplies
    b. Delivering or shipping items
    c. Finding new ideas for items or designs
    d. Learning or practicing new processes or techniques
    e. Making items
    f. Providing customer service (e.g., answering emails or messages, making mock-ups, etc.)
    g. Updating your website or place where your sell your items
    h. Updating your business social media accounts (e.g., Instagram, Facebook group, Twitter, etc.)
43. What are the best and worst things about running your business? *
44. Approximately how much profit does your business make per year (i.e., the amount earned minus expenses)?
    a. I don't track how much I make
    b. Less than $1,000
    c. $1,000 - $4,999
    d. $5,000 - $9,999
    e. $10,000 - $24,999
    f. $25,000 - $49,999
    g. $50,000 - $79,999
    h. More than $80,000
45. Do you have any other comments or thoughts that you would like to tell us about your use of cutting machines, the items you make, your clients, or your business? *

Appendix B: Semi-structured Interview Questions

Work / Life Balance:

1. Where do you use your machine?
2. Do you feel you have balance between your business and life?
3. Would you still run your business if you didn't have to make designs?
4. How did you start using the equipment and social media for your business?
5. How are your social networking accounts organized for your business and personal life?

Process and Troubleshooting:

1. Are you a part of any online groups for your machine? Do you use them to get help? How?
2. How did you get information about your machine or new features?
3. What do you do if a material won't cut or didn't cut all the way through? How do you fix this / learn to fix this?
4. What do you do if your machine stops working? How do you fix this / learn to fix this?
5. What do you do if the software stops working or freezes? How did you learn to do this?

Advertising and Research:

1. Do you use any aggregation or analytics software / tools to find out more about your customer base?
2. Do you do any market research (e.g., online surveys, contests to get information, feedback forms, etc.)?
3. How do you attract clients (e.g., deals, discounts, customer loyalty programs, affiliate programs, influencer programs, referral bonuses, etc.)?
4. How do you pay attention to what your competitors do?

Feedback:

1. Do you ask others to critique your designs (either in person or online) before you make them or offer them for sale?
2. Do you share your designs, failures, or ideas with others online?
3. Does your Facebook page or website allow customers to leave reviews?
    a. Do you like this feature?
    b. Would you turn them off?

Business:

1. What are your long-term goals / plans for your business?
2. Who initially funded your business? Your personal funds, family/friends, bank?
3. How do you keep track of your orders, customer requests, urgent / rush orders, etc.?
4. How do you keep track of mock-ups, graphics files, etc.?
5. Does the government know that you run a small business (e.g., collect and remit GST/HST/QST/PST, T2125 Statement of Business or Professional Activities)?
    a. If no, why not?
    b. If it was easier to do this, would you register and become a legal business?

After Sale Support:

1. After you sell something, do you include any usage or care instructions (washing, warnings, etc.)?
2. Do you offer any warrantees or guarantees for any of the items you make?
    a. Should this be a necessary part of selling online?
3. Do you have any after-sale support strategies or techniques to retain customers?
    a. How did you develop these policies?