How Transgender People and Communities Were Involved in Trans Technology Design Processes

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ABSTRACT

Trans technology – technology created to help address challenges that trans people face – is an important area for innovation that can help improve marginalized people's lives. We conducted 104 interviews with 115 creators of trans technology to understand how they involved trans people and communities in design processes. We describe projects that used human-centered design processes, as well as design processes that involved trans people in smaller ways, including gathering feedback from users, conducting user testing, or the creators being trans themselves. We show how involving trans people and communities in design is vital for trans technologies to realize their potential for addressing trans needs. Yet we highlight a frequent gap between trans technology design and deployment, and discuss ways to bridge this gap. We argue for the importance of involving community in trans technology design to ensure that trans technology achieves its promise of helping address trans needs and challenges.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Empirical studies in collaborative and social computing**.

KEYWORDS

trans technology, human-centered design, technology design processes, transgender, LGBTQ+

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1 INTRODUCTION

Historically, Human-Centered Design has approached inclusivity from a universal design approach, or designing for an "average" user [33]. However, people often struggle with using technology when it has not been designed to address their specific needs [15]. For individuals whose experiences and needs are not represented in technological systems, using technology is often arduous and sometimes harmful. This issue is pervasive for transgender individuals, a particularly marginalized group, because most technology is not designed with trans people in mind [24]. However, most studies about technologies have not solely focused on trans people.

Trans technology is technology designed specifically to address some of the challenges trans people face in the world [24], and is often designed in response to the lack of representation in more mainstream technologies. In this paper, we use this practical definition of trans technology rather than a more theoretical definition [23]. We expand on Haimson et al.'s [24] work on trans technology by providing an extensive view of design processes in the current trans technological landscape. Trans technology includes apps and websites, but also technology like augmented and virtual reality systems, online communities and support groups, wearable technologies, podcasts, digital art, games, and much more.

In this paper, we describe trans technology design processes. We ask (**RQ1**): To what extent, and in what ways, were trans people and communities involved in trans tech design processes? We begin by describing several projects that involved community members throughout the full design process, such as via participatory design approaches. Then we discuss some of the ways that trans tech designers[1] involved community members in design to some extent, such as by gathering feedback from users, conducting user testing, or being trans themselves.

This research helps us to understand how trans technologies are designed and developed, the importance of community-based design approaches, and how trans tech designers' own identities interplay with their technology creation. We argue that trans technologies are most impactful when their development involves community members, as this enables technology creation that best addresses trans needs. Additionally, involving trans perspectives

[1]By "trans tech designers" and "trans tech creators," we do not mean that creators were necessarily trans themselves. We mean that they were creators of trans technology. We use "trans tech creators" and "trans tech designers" to stay in active voice rather than passive voice (e.g., "creators of trans technology"). While 80% of creators in our study were trans and/or nonbinary, some were cisgender.

and lived experiences facilitates a reworking and rethinking of technology design to benefit trans people. Examining the different design processes employed in trans technology development provides insight about the limitations of more commonplace design processes, specifically how these practices can overlook the needs of marginalized users. Understanding the relationship between community involvement and meeting users' needs in trans technology design provides insight into how the design process can involve marginalized communities to create technology that adequately supports them. We highlight a frequent gap between trans technology design and technology deployment; in cases where trans people and communities were involved in design processes, which typically happened in more academic settings, the technologies were often not fully deployed or used by the people who need them most. At the end of this paper, we will present a few approaches to help bridge this gap.

In this work, we make the following contributions:

- By conducting a large-scale interview study with trans technology creators, we provide an empirical understanding of how, and to what extent, marginalized users are involved in design processes. In this way, we go beyond considering how design processes *should* work to illuminate how design processes actually work in practice in this context.
- We expand on previous research on trans technology [1, 4, 23, 24] and technology designed for marginalized populations [17, 19, 29] to describe design processes among a large sample of the current trans technological landscape.
- We provide four suggestions for how successful trans technology design processes can move beyond design to deployment: create programs to bring designs from classrooms and academic research to deployment, match trans tech designers and developers, connect tech creators with community members, and make more space for publishing on technology deployment and user studies. These suggestions aim to increase the implementation of technology that more effectively meets trans people's and communities' needs.

2 BACKGROUND AND RELATED WORK

2.1 Human-centered design processes

Human-centered design is a technology design process in which people who will be using a technology are involved throughout its design process. A human-centered approach is important because each of our own personal experiences is limited, and we cannot possibly anticipate all aspects of how people will use a technological system. It is only by asking people, and having them interact with the technology, that we can see what we might have missed and how we can better design to meet a wider range of users' needs [45].

Traditionally, most technology was designed with minimal user input [46]. User-centered and human-centered design evolved from a history of ergonomics and human factors and in the 1980s became more widely used in system design [52]. In a user-centered or human-centered approach, the design process began to more rigorously include user testing, ideation with users, and iteration [47], and shifted away from one-size-fits-all design approaches [52]. HCI scholars often describe the human-centered design approach as "design thinking," defined as a design process that involves ideation, generating many alternative solutions, and iteration [61] to take a user-centric problem solving approach [20]. Using a wheel, or a series of arrows, is a common approach to visualizing the human-centered design process and design thinking [20, 54]. The wheel or arrows symbolize the fact that human-centered design is an iterative process rather than a series of sequential steps, and that after each encounter with users, the designer can and should go back and adjust their design.

In the design thinking process [20], users come into the process in several primary places. First, in the requirements gathering phase, designers conduct initial research with potential users to build a greater understanding of their needs, identities, and use contexts [54]. Requirements gathering involves things like conducting interviews, surveys, and sometimes participatory design sessions with people who are the intended users of the technology. Another primary part of the process where users are involved is the testing phase, in which a designer presents their prototype to users and gathers feedback through methods like task analysis [45, 54]. Testing can involve user testing, play testing (for games), or any type of activity that puts the user in front of the technology so that the designer can determine whether it works as intended, understand places where it does not, and get valuable feedback to improve the design. Importantly, human-centered design is not a binary, but rather a spectrum; there are many ways that designers can involve users in design processes, ranging from not at all to involving users in a participatory fashion during every step of the process, along with all possibilities in between.

Some designers use more participatory approaches, such as participatory design. In participatory design processes, participants are not just research participants, but are "legitimate and acknowledged participants in the design process" [55]. That is, to some extent, users become collaborators and designers themselves. Participatory design "is driven by social interaction as users and designers learn together to create, develop, express and evaluate their ideas and visions" [55]. Participatory approaches are especially important when designing technology for marginalized populations, because designers often bring assumptions and goals into the design that may not align with communities' goals [19, 29]. Engaging marginalized groups in the design process helps designers to critically interrogate their assumptions, but it requires substantial time to develop trust with communities [19, 29]. Additionally, designers must be aware of tensions such as the historical context of the research environment and potential unintentional harms that the collaboration may invoke [29].

The design justice approach, described by Sasha Costanza-Chock in Design Justice, provides a way to think critically about design, and consider how design can more equitably distribute technology's potential benefits and harms among people [15]. The Design Justice Network's principles advocate for a community-centered design approach that aims to work with marginalized communities without further burdening them [15]. Design justice involves asking three primary questions throughout the design process: "Who participated in the design process? Who benefited from the design? Who was harmed by the design?" [15]. This approach diverges from design thinking as it ensures that technological innovations benefit marginalized communities, rather than just improving designs

and heralding innovation. In that sense, design justice is a much more appropriate approach for trans technology design, and we provide an understanding of how trans individuals and communities sometimes participated in and potentially benefited from trans tech design.

2.2 To what extent do designers and tech creators involve users in design processes?

HCI scholarship has examined different user involvement techniques and their impacts, ranging from reflective user involvement in open source projects to engaging end users in design competitions to improve systems [3, 13]. While involving users is key to human-centered design, the actual practice of user involvement in design processes varies. Different levels of involvement require various techniques from participatory design to heuristic evaluation [2]. Studies have shown that user involvement differs at each stage of the design process [8, 11]. In a comparative study of eight high-tech firms, Bosch-Sijtsema and Bosch [8] found that many firms involved users in earlier stages of the design process and collected input through qualitative methods to collect rich, in-depth data. However, for cases that involved users in later development stages, the user involvement was largely passive; data was collected through other methods, such as A/B testing, in order to understand how users interacted with prototypes or new features [8].

Some research found little evidence of human-centered design processes being used in practice. Carthy et al. [11] found few designers involved users during ideation in comparison with later stages of development, such as identifying current user pain points and developing prototypes. On the whole, "it would appear that user involvement is not apparent throughout all stages of the design process... [and] for the most part, design thinking approaches are not used to the extent recommended in the literature" [11].

While identifying users to involve in the design process has several notable approaches from identifying typical user personas [41] to atypical or extreme user personas, another interesting avenue for user involvement is autobiographical design [44]. Autobiographical design refers to "design research drawing on extensive, genuine usage by those creating or building the system" [44]. Incorporating autobiographical design supported fast tinkering with designs, allowed design to address genuine needs for the technologies, enabled designers to identify 'big effects' that could make or break a system, and provided a detailed, experiential understanding of their own design [44].

Notably, much of user involvement literature does not explicitly apply an equity or justice-oriented framework to their studies. However, it is clear that interaction design practices can perpetuate otherness and/or promote equity in their executions [18]. In examining several design processes across several studies, Brito do Rêgo et al. [18] emphasize that "alternative interaction design practices highlighted the importance of including users beyond the designers' interests" as well as the particular importance of being attentive to context and power during the design process. Moreover, it is difficult to assess whether otherness or equity are being addressed in these design processes because of the lack of explication by the designers in reflecting on their processes [18].

While we have reviewed work that examined user involvement in design processes, there is little documentation of how marginalized groups are involved in technology design processes. Some HCI scholars describe their processes of involving marginalized users in technology design in the context of one study, such as in research with queer and trans communities [1, 10, 24, 26, 27, 37, 40, 50], racial and ethnic minorities [28, 28, 51, 60], and in ICTD [32, 35, 43, 59]. Yet, there is value in going beyond one study to examine user involvement in a large set of design processes. We expand upon prior research by studying design processes across a wide range of different types of trans technologies. This approach gives us new insights about how people and communities, particularly marginalized groups, were involved in design processes.

2.3 Trans technology and HCI

Trans technologies, or technologies that help address some of the challenges that trans people face in the world [24], often allow trans users the flexibility, multiplicity, and ambiguity needed for gender transition [23]. Most technologies do not fully consider change or transition, causing difficulties for people who are trans and/or non-binary, who often face unique experiences related to marginalization [6, 23, 34, 56, 57]. Trans technologies ideally allow trans users to explore identity, find ways to increase their safety, find resources, and build community, and trans-inclusive design requires considering how to account for trans users' needs in these and new ways [24].

HCI, "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them," [31] is a complementary frame to study trans technologies. The 'major phenomena surrounding' trans use of technologies are important because incorporating users in the design process can lead to improved systems [15, 45]. To improve technologies for trans people then, it follows that including trans people within the design of technologies could help address issues such as transphobia or trans-exclusion in technology. Several studies have used participatory design methods to design with and for LGBTQ+ people [10, 26, 27, 40, 50], but few have focused solely on trans populations [1, 24, 37].

Several HCI studies have explicitly examined the world of trans technologies by either studying or designing technology that helps address trans needs and challenges. Although framed as a study on Queer UX, Beare and Stone [5] performed a study on two mHealth platforms that provided access to gender-affirming hormone therapy, finding that platforms such as Plume and FOLX offer a look into the queer potentials of healthcare providers and technologies, which involve trans people in the design process [5]. Other HCI studies involving trans technologies include Ahmed et al. [1], who developed free, open source voice training technologies for trans people and Liang et al. [37], who designed an online sex education resource for gender-diverse youth. Beirl et al. [7] designed a mobile app to help trans people find gendered toilets around people who support gender diversity. These trans technologies all provide resources and information to trans people that they would not otherwise have easy access to.

Not only do trans people need resources and information, but they also face issues with their digital identities, which often invalidate how they express their gender or identity [21, 22]. Automatic facial and gender recognition systems are emblematic of this gender and identity invalidation [25, 36, 53]. To combat these systems, Baeza Argüello et al. [4] developed prostheses to train Apple Face ID to recognize modified/different facial identities and Chong et al. [12] developed a virtual makeup support system to help trans users pass and be perceived as the gender they identify as. Additionally, many technologies fail to recognize non-binary identities, as Spiel et al. [57] speak on. Being recognized as male or female by these technologies and systems may be validating for some trans people, but for some non-binary people, this binary choice of presentation can be limiting and invalidating.

In this research, we examine trans technology more broadly than just one system or design by talking with creators of over 100 different trans technologies, enabling us to expand upon prior work on trans technology in HCI.

3 METHODS

3.1 Data collection

For this paper, we conducted 104 interviews with 115 creators and designers of trans technologies in 2021 and 2022. We used criterion sampling [42], an approach in which we selected participants who met a particular predetermined criterion – in this case, being creators, designers, or developers of some type of trans technology. Additional inclusion criteria included the ability to speak and understand English, and being 18 years old or older. To recruit participants, we created a list of potential trans technologies by drawing from several years of observing the trans technology landscape, as well as systematically searching app stores and search engines for key terms, including "transgender," "transgender technology," and "transgender apps." We continued to expand the list through snowball sampling by asking interviewees to recommend other trans technologies or trans tech creators. We use the term "technology" very broadly. Table 1 lists the categories of technology in our dataset and examples of each. We contacted participants via email or social media to invite them to participate in the study; our response rate of completed interviews was 43.7%. We conducted semi-structured interviews via Zoom that lasted approximately sixty minutes (mean = 63 minutes, standard deviation = 14 minutes, range = 33-93 minutes). We asked participants about the story of their technology's ideation and creation, their design processes and who was involved, challenges they faced, their conceptions of trans technology, and more. With a semi-structured format, interviews focused on topics most salient to participants. Participants were compensated with a $100 gift card or check. This study was reviewed and deemed exempt by University of Michigan Institutional Review Board.

Table 1: Types of Trans Technologies and Examples from Dataset

Technology Type	Number (%) (n = 104)	Examples
health resource	15 (14.4%)	Erin's Informed Consent Map, RAD Remedy
resource	15 (14.4%)	Trans Language Primer, Transgender Map
game	14 (13.5%)	Tabitha Nikolai, D. Squinkifer
archive or database	9 (8.7%)	Digital Transgender Archive, Transpedia
body technology	9 (8.7%)	Open Source Gendercodes, Transthetics
art	9 (8.7%)	Heather Dewey-Hagborg, Edgar Fabián Frías
transition app	6 (5.8%)	TRACE, Solace
extended reality	6 (5.8%)	Through the Wardrobe, Machine To Be Another
browser extension	5 (4.8%)	Deadname Remover, Gender Neutralize
safety technology	4 (3.8%)	Arm the Girls, U-Signal
social media	4 (3.8%)	Trans Women Connected, Flux
supplies	3 (2.9%)	Trans Tape, Transguy Supply
voice technology	3 (2.9%)	Christella VoiceUp, Project Spectra
podcast	3 (2.9%)	Gender Reveal, GenderMeowster Podcast Network
online community	3 (2.9%)	Trans Peer Network, Transgender Community Forum
streaming	3 (2.9%)	Gender Federation, The Transverse
dating app	2 (1.9%)	Tser
appearance-changing technology	2 (1.9%)	makeup support system, Apple Face ID for new hybrid identities
crowdfunding	1 (1.0%)	To Be Real
hackathon	1 (1.0%)	Trans*Code Hackathon

Many technologies fell into multiple categories, so percentages add up to greater than 100%.

3.2 Data analysis

We audio-recorded interviews and later transcribed them for data analysis. Data analysis took place alongside data collection, and we iteratively adapted our interview protocol based on what we were learning through analysis. We began by open coding [14], drawing out major themes such as ways trans people were involved in design processes. Through an iterative coding process, we developed themes and continued to revisit and refine them; we also deductively coded for particular design processes and approaches. In this paper, we focus on codes related to community involvement and human-centered design processes in ideating and designing trans technologies. As such, we only discuss those trans technologies that did include trans people in design processes. There were also many trans tech creators who did not involve trans people or communities in design, aside from perhaps themselves. In our study, roughly 42% of trans technologies did *not* involve trans people or communities in design processes at all. We leave stories about those design processes for future work, as they are beyond the scope of this paper.

Following a reflexive thematic analysis approach, we engaged in an iterative data analysis process consisting of six stages: familiarization; coding; generating initial themes; reviewing and developing themes; refining, defining, and naming themes; and writing up [9]. Reflexive thematic analysis is a theoretically flexible method of analyzing data which acknowledges and uplifts the researchers' roles in conceptualizing themes from the data. Thus, the researchers' roles in conceptualizing themes is key, since the themes do not "emerge" but are rather shaped by what the researchers bring (e.g., research values, skills, etc.) when they engage the data.

While data analysis was led by the first author, our process of generating and refining themes was collaborative in several ways. First, the first author discussed themes and codes and potential relations between the two with all coauthors on a regular basis throughout the year we collected and analyzed data. Next, all authors completed memos regularly following interviews and during transcription and

data analysis, and then we read each others' memos to inform our own thoughts about the data and its meanings. Finally, two authors collaborated on and discussed an interactive Miro board where we mapped out codes and themes and their relations.

3.3 Participant demographics

Table 2 details participants' demographic and geographical characteristics.

Table 2: Participant Demographics

	Number (Percentage) (n = 115)
Gender	
Trans woman and/or trans feminine	39 (33.9%)
Trans man and/or trans masculine	32 (27.8%)
Nonbinary	27 (23.4%)
Cis woman	17 (14.8%)
Cis man	6 (5.2%)
Trans (self-identified as "trans" only when asked about their gender)	2 (1.7%)
Race	
White	90 (78.2%)
Asian	17 (14.8%)
Latinx/e	12 (10.4%)
Black	6 (5.2%)
Indigenous	3 (2.6%)
Middle Eastern	2 (1.7%)
Other (self-identified as "other" when asked about their race)	2 (1.7%)
Multiracial	17 (14.8%)
Age	
Mean: 37 (SD = 11, range: 20-84)	
Country of residence	
United States	86 (74.8%)
Canada	10 (8.7%)
United Kingdom	8 (7.0%)
Australia	4 (3.5%)
Spain	3 (2.6%)
Brazil	1 (0.9%)
Ireland	1 (0.9%)
Japan	1 (0.9%)
Switzerland	1 (0.9%)
Many participants described their gender and race as falling into multiple categories, so percentages add up to greater than 100%.	

3.4 Limitations

While our sample is diverse, we acknowledge that the vast majority are based in the US and speak English. We recognize our sample reflects our limited knowledge of trans technologies based on this context. We also acknowledge that more than 75% of participants were white. Especially given that many designers relied on their own experiences to create technologies, this poses an issue for understanding the practices and needs of those who are minoritized, particularly trans people of color.

Lastly, the study uplifts trans technology creators and designers' reflections on how their own design processes unfolded and does not account for how community members or users experienced the design processes. We encourage future studies to explore community members' experiences with trans technology design processes.

4 RESULTS

In this Results section, we describe trans technology design processes. We begin by describing several projects that involved community members throughout the full design process, such as via participatory design approaches. Then we discuss other ways trans tech designers involved community members in design, such as by gathering feedback from users, conducting user testing, or being trans themselves. We find that involving community members increases the impact technologies can have in helping to address trans needs and challenges, and allows designers to reimagine technology's potential in the service of benefiting trans people.

When designing with trans communities, many times the designers themselves are also trans; in our study, 80% of designers were trans and/or nonbinary (the rest were either cis allies, or people who were actively questioning their own genders). The creator being trans themselves was the most common way of incorporating trans people in trans tech design, and often trans creators teamed up with another or a group of other trans people to create their trans technology. Tuck Woodstock[2] described Gender Reveal as *"a podcast made by trans people about trans people, primarily for trans people,"* and Taylor Chiang stated how they *"really want[ed TranZap] [a trans healthcare resource app], what it's driven by, the input, the building of it, really making that trans focused... I like being able to say that this was built by trans folks, this was built by the feedback of trans folks."* For Trans in the South, a trans healthcare resource site, creator Ivy Hill described, *"Well, I'm also trans, so I think it is important that it was built by trans people for trans people. A lot of resources are not. So, that has been central to the whole process I think."*

Shared identity with the people who will be using a technology can be a great advantage – after all, the designer knows the trans experience intimately, and often feels like an expert in navigating the needs the technology is designed to address. On the other hand, no one trans designer (or small group of designers) can possibly embody or understand the full range of trans experiences that must be accounted for in design, especially when considering that many trans people hold multiple marginalized identities (e.g., trans people of color). Thus, it is still vital to include trans communities in design processes even when a designer themselves is trans or a design team includes trans people. In our research, about 19% of the technologies meaningfully used a human-centered design approach by involving trans people and communities throughout the full design process, while an additional 39% used some aspects of human-centered design but did not involve community members throughout. 42% did not involve trans people or communities in design processes, aside from perhaps the creator themselves being trans.

[2]Most participants in this research explicitly wanted to be identified rather than anonymous, so we use their full names here, with permission. Other participants wanted us to use first names only, or pseudonyms, or wanted to remain anonymous. We report names based on participants' wishes in every case.

4.1 Human-centered and participatory design processes

In some trans tech design processes, creators stuck closely to a human-centered and participatory design process, in which community members were involved in ideation, design, testing, and iteration.

Guilherme Colucci Pereira and his collaborators used participatory design methods over a period of more than six months to create LGBTrust, an app to help increase safety for trans and queer people in Brazil. The process involved a series of workshops, in which participants were involved in the design process *"since the beginning, from having the idea and discussion of what this app would be, until the prototyping and until the evaluation, the first usages. This group of people participated in everything."* Pereira began the project without a sense of what exactly he and the design workshop participants would be creating. In early design sessions, Pereira stated, *"I tried to make it very clear that I had no idea about what kind of application we would end up with. I had no idea of what kind of topics we would face and we would embrace."*

Throughout the design workshops, a focus on safety emerged:

> *This is very deeply related to all these concerns about violence in Brazil. So it was natural to talk about and to think about safety: how to create a safe place... to share about what places you should be careful, where you should not go... But it was not given by me – it was not my choice at the beginning. It was just the natural development of the project.*

In this human-centered design process, Pereira learned along with participants that safety was a primary concern, and that the technology design should focus on safety. When we asked Pereira what he found to be the most exciting part of the LGBTrust design process, he discussed the participatory approach and the fact that it enabled the technology design to go in unexpected directions:

> *I think this surprise, because it validated the choice for the participatory approach, because for sure I couldn't do this by myself. And to see this meeting by meeting, exercise by exercise, growing, and always being meaningful... It was very rewarding...*

Not only was the human-centered approach satisfying for Periera and his team, it also ensured that the technology design focused on the topics most salient for the workshop participants, and likely for trans and queer people in Brazil more broadly: safety.

Meanwhile in Barcelona, Saúl Baeza Argüello and colleagues used participatory human-centered approaches to develop a series of prosthetic facial devices that enabled people to present several different digital identities via Apple Face ID. Baeza Argüello explicitly considered this tool to be a trans technology because it enables "identity ambiguity, multiplicity and fluidity," aligning with a previously published definition of trans technologies [4, 23]. While Baeza Argüello and the team did not approach the design process in as open-ended a way as Pereira did, they did hold a series of design workshops in which they involved participants in meaningful ways to determine how to design and deploy these technologies. The design team wanted to determine *"all the outcomes that are possible with this technology,"* so they organized a design workshop with a goal to *"mix a lot of different perspectives, personal positions, and so on."* Collaboratively, the designers and workshop participants worked to understand the range of possibilities for the facial prosthetics. The research team ensured that the workshops were accessible to people with little technical knowledge, and that they were playful rather than serious, with a goal of enabling people to express and communicate their identities. Describing the process, Baeza Argüello said:

> *We're not [explicitly] saying the specific uses of what we're developing. Our aim is to really open [up] that conversation, put those tools [out] there and see how people can express a lot of different values. That's why it was super important for us to get all those different opinions.*

The workshops were successful in enabling people to explore hybrid physical and digital identities with facial prosthetics, which Baeza Argüello described as a *"super interesting approach and experience between all the people involved,"* primarily because of the trust that the participants and researchers developed with each other throughout the process. However, Baeza Argüello described how the process was not easy, but rather was quite *"difficult and stressful in the beginning."* The participatory design process was tricky because it required actively learning how to bring a group of people into the design process, how to ensure that all workshop participants became involved, and how to enable each participants' unique narrative to be represented in the technology.

Another project, Flux, a transition and community-building app designed by a team of students at University of Michigan, took an explicitly human-centered design approach, involving trans people of color in design workshops to envision and design the app. Flux was designed as part of the University of Michigan master's level course Introduction to Interaction Design, taught by HCI scholar Tawanna Dillahunt, and the course's approach to design likely strongly influenced the extent to which the app was designed in collaboration with the trans community.

Denny Starks, another alumnus of Dillahunt's class, also created a trans technology – U-Signal, a wearable technology and app to increase safety for trans people of color [58] – for their semester project.

> *Tawanna's... very big on research. So she makes sure that research is a big part of the process, and teaching us different methods. And I really appreciate that... The most important part of the design process for me is always talking to the users, getting their opinions. And she made sure that we did that every step of the way... Always talking to users, and just going to them and being like, "Okay, what do you think now?"*

Over the course of a semester, students in Dillahunt's class often did not have the time to conduct participatory design sessions, though they did learn about the method. Starks hopes to employ participatory design to further iterate on U-Signal:

> *I want to take a more participatory approach, and this time really, really work with them side by side... I really want to give them more control, and let them know, "Hey, this is for us, by us. This is not just a me thing." And that was part of checking myself in the design*

> *process, of having to take my own feelings and opinion out of it.*

We suspect that Flux and U-Signal are two of many trans technologies designed using human-centered design processes in classroom settings across the world in recent years (though in our dataset, these were the only two).

Examples like LGBTrust, Flux, and the others in this section demonstrate how meaningful trans community involvement enables trans technologies to evolve to meet community needs, rather than simply fulfilling the designer's predetermined goals.

4.2 Requirements gathering and initial research

The majority of trans technologies whose creators we spoke with were not designed using a human-centered approach throughout the whole design process, but did incorporate elements of human-centered design in some ways. For instance, before designing and developing technologies, many trans tech creators conducted initial research to understand more about the people and communities who would use their technology. In human-centered design, this is known as "requirements gathering" [54]. For instance, in the early stages of designing the Euphoria suite of transition apps, while at the Trans*H4CK Hackathon[3], Robbi Katherine Anthony (who also goes by RKA) described:

> *during that weekend, we started with the survey asking users what was keeping them stuck in transition, because in my personal experience, that's the worst place for someone to be. And our... survey respondents identified a few different things, but primarily, it was a lack of accurate and reliable information, the financial means to be able to afford it, and the safety and the community aspect. And those became our three pillars for all the different apps we would design.*

In this way, Euphoria was able to identify user needs that they could address with their technology.

Initial research with communities was sometimes more involved and intense. For example, Rob Eagle, creator of Through the Wardrobe (an augmented reality identity exploration experience), described their ethnographic work with local trans and queer communities:

> *So it became a field site, but it was also my home. And so those boundaries as well, between insider/outsider, between ethnographer and "supposed to be the professional person" and the non-professional person, a lot of those blur, I think, particularly within a long term ethnography in which you are really embedded within a community and where you become a part of that community, the community becomes part of you. So of course, that's all going to blend together.*

Though Eagle was a researcher, they were also a community member, and Through the Wardrobe was a way that they connected to local communities on a personal level after recently moving to a new location. This embedded approach strengthened the project, as it enabled Eagle to bring in their own experiences blanketed in the community's experiences more broadly.

[3]a trans hackathon series led by Dr. Kortney Ziegler

Sometimes, conducting initial research changed important elements of the project. For instance, Starks initially envisioned U-Signal as a wearable technology:

> *I really wanted to focus on wearable technology. But then when I started to work with participants, they were like, "Oh, we would like to have a smartphone app." So it is also a smartphone app that comes with... a smart watch.*

micha cárdenas faced a similar tension in her project Autonets, a series of technological garments that used wireless transmitters to alert people in one's network if they were unsafe. cárdenas described the process in her book [16] and also in our interview:

> *I had been an artist working with GPS technology for years on the Transborder Immigrant Tool. When I took that to communities to think about trans safety, a lot of the communities were like, "no thanks." So, then I switched the approach to being not about GPS, but just about detecting proximity with signal strength [the Autonets project]. Even then, when I started working internationally with groups in Colombia and Brazil, they were like, "that's cool that you can make a $100 hoodie, but if we had $100, we would buy smartphones." Real cost prohibitive news for the communities that I wanted to work with. So, I changed the approach, and I think about that as part of the design process. I've been really inspired by the Design Justice Network, Sasha Costanza-Chock's work, and Una Lee's work. Thinking about design as a process that could center affected communities instead of just centering the designer.*

Eventually, cárdenas changed her project entirely to be non-digital, which was more aligned with the community's feedback. Even though a designer might have a particular form factor in mind, such as wearable technology, designing to fully address community needs means understanding what types of technology would work best for them and working around anything that would prohibit communities from actually using the technology. In the case of these safety technologies, communities expressed their clear preferences for technologies that were different than what the designers initially envisioned. These examples demonstrate how trans community involvement in the early requirements gathering phase of design ensures that the resulting technologies meet the community's needs.

4.3 Gathering and incorporating feedback from users

Creators who did not fully commit to a human-centered design approach still often included trans community members by soliciting and incorporating feedback from trans people. Gathering feedback took many different forms, including informal conversations and listening to users, circulating surveys, feedback forms, user reviews, and receiving feedback at public exhibitions.

Nolan Hanson from Trans Boxing, a boxing club and art project, described their approach:

> *Getting feedback from people that have been involved for a long time is really valuable for me, and so is first-time feedback too... A lot of it is just informal conversations. And a lot of that's not visible to other people. Nobody knows that I'm here talking on the phone with this person, or that Kerry [a TransBoxing trainer]'s emailing, but to me that feels like a really valuable component.*

Yet as Nolan described, efforts to involve community members and incorporate their feedback were sometimes invisible to others, which is likely true for many technological efforts and organizations.

Gathering feedback via surveys, feedback forms, and user reviews was a common approach. RKA from transition resource app Solace described gathering feedback from users via a survey. *"So on all of our surveys we have multiple open-form questions for people to be able to say 'what do you wish Solace could do that the app can't?'"* RKA said. She continued:

> *One of the biggest complaints we got was that there's no way to change your name in the app itself, which is an incredibly glaring design decision on our end. But that was one of those points that we're able to say, "okay, how do we actually design around this," because this problem probably reflects more than 51% of this patient population.*

In this way, gathering user feedback enabled Solace to discover an issue that trans people typically face in mainstream software, but would not expect to encounter in a trans-designed app.

Wayne Temple, creator of the True Self browser extension that replaces one's prior name with their chosen name, also relied on user feedback to find a design flaw that kept his browser extension from being truly trans-inclusive. He had designed the extension to be persistent, so that *"once you put it in, every time you open your browser it's there, which can obviously have drawbacks for people in shared scenarios who maybe can accidentally get outed..."* Yet interestingly, in user reviews, the feedback was split – some users liked the persistent nature, while others expressed frustration in potentially being outed. Temple considered a potential solution to address both camps: "Maybe I should figure out a way in another iteration where I can maybe allow the user to turn that off so that it doesn't persist." A toggle switch for persistence could be a simple yet elegant solution.

Transition-tracking apps like Transcapsule and TRACE gathered feedback from users in their beta versions by using Testflight, a beta testing platform that enables users to directly provide feedback through the app. After officially launching, TRACE continued to gather user feedback using an online platform called Canny, and posted in the app to invite users to provide feedback (see Figure 1). In these posts, TRACE positioned itself as different from other apps because they listened to community feedback: *"Don't worry, we aren't just 'an app,' we are a part of this community,"* emphasizing the community-centric nature of the app and implying that human-centered design approaches are relatively uncommon.

Before developing Pryde Voice & Speech Therapy App, creator Erin Gitelis gathered feedback from users of other existing speech apps, to determine how to design hers: *"So I read through those reviews, what people didn't like, and then tried to stay away from*

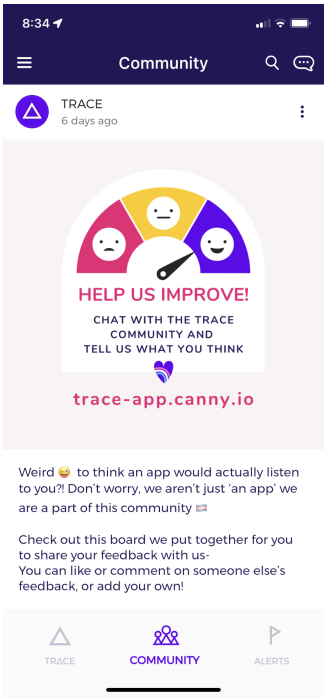

Figure 1: Screenshot of TRACE's efforts to gather user feedback after launching.

that, and what they wanted more of and try to add more of that in mine." We found reading existing technology's user reviews to be a creative approach to gathering user feedback that we expected would come up in more interviews, but surprisingly Gitelis was the only person to mention this technique.

Positive feedback, while nice to hear, is not always particularly helpful for creators. Sandy Stone described the audience feedback that she and her team received when launching their Public Genitals Project, an art project in which people placed screens displaying strangers' genitals over their crotch area.

> *The audience members were... I mean, they're not articulate in the way that you might think. They said, "oh, I love it." Or "isn't that interesting?" I don't remember anyone asking questions about, "how did you put it together? What questions did you ask?"... No one said, "tell me more about the aesthetic details of this." People just said, "oh, I like that." So there you have it.*

Interestingly, Stone focused on both the things people did say, as well as what they did not say, revealing some of the limitations of involving people only at the tail end of design processes when a project was complete. Audience members may not have asked about the aesthetic details or the project's guiding questions, but had they been involved earlier in the design process, they could have potentially influenced both. Yet in this particular case, though the Public Genitals Project technology can be read as trans, its design team was primarily cis. It is likely that, in Texas in the 1990s, there were few trans people at the exhibit. Involving more trans people in the design process would have been a difficult task, given the time

and location. This example demonstrates some of the difficulties inherent in involving trans people in design processes.

The examples in this section highlight how, in many cases, gathering feedback from users enabled designers to improve their designs and fix potentially problematic elements, which made the resulting technologies more well-suited to address trans challenges.

4.4 Trans people and communities involved in design processes

Beyond just gathering and incorporating feedback from users and from trans people, some trans tech creators involved trans people and communities in the design process in larger ways, yet still without employing a fully human-centered or participatory design process. Ways trans tech creators involved trans people and communities in design included collective governance, intentional community-building, involving trans people as collaborators, involving trans online communities, incorporating the community's ideas and values into the project, and via trans advisory boards. We will describe and give examples of each.

Delilah D'Lune, creator of Royal Jelly, an online porn content creation site that is still in development, described how forming connections with community members (in porn and sex worker communities broadly, but also specifically with trans porn creators) was a fundamental part of the design process. This was in contrast to her previous trans technology, a trans-specific social media site that never really took off, which D'Lune attributed in part to its lack of meaningful community buy-in. D'Lune described that she was spending time *"developing the platform, as well as developing connections in the community, unlike with [prior social media site], which was [not]. We have very strong connections and a number of other developers who are volunteering their time."* Royal Jelly also uses a community governance approach to make sure that each person contributing to its development also has a say in decisions about the platform. For Trans Boxing as well, community involvement was essential. While the organization was run in a more top-down fashion, with Nolan Hanson making decisions, the group of trainers and trainees working together regularly created a community atmosphere in which trainees felt ownership as well. In this way, the organization itself became a community in which people supported each other and contributed their ideas.

Some trans technologies were able to involve trans people on a more creative level. Dylan Paré described their Creative Futures project (a collaboration with Scout Windsor) [49], in which they worked with three trans youth to create virtual reality (VR) art for immersive storytelling that eventually became two films (see Figure 2):

> *The linear film would tell the story of how these youth came up with their ideas of what stories they wanted to tell, and what they were hoping people would learn from their projects. The 360 [film] was where you actually can go into the art with them, and they tell you about their art that they've created, and what that means to them.*

The process was time-limited due to funding constraints, and so all of the work happened within a single weekend.

> *That was the time we had with them to teach them how to make the art and have them turn around and actually have made something. It was really, really intense, but they also did an incredible job. That was also really rewarding in that way to see what they could do in such a short period of time.*

At the same time as the project enabled Paré and Windsor to tell diverse trans stories using an innovative medium, it was also a way to teach VR skills to young people.

Figure 2: Images from the Creative Futures project's film [49] showing trans young people's VR creations.

When creating trans resources, trans tech creators often made sure to involve community in the process. *"We felt like it was really important for it to be community-driven and to be both a community resource and a community project,"* said Riley Johnson, creator of trans healthcare resource site RAD Remedy. RAD Remedy regularly hosted workshops where trans people gathered to compile resources, and also garnered a lot of interest from trans community members who wanted to be involved as volunteers. To make sure that their volunteer work was meaningful, RAD Remedy would ask potential volunteers several guiding questions: *"'What do you like to do? What are you good at? How much time do you have?' Those guiding questions, we did it for everything,"* said Johnson. Similarly, by hiring a team of "translators" who can translate their local community knowledge of trans resources, the Trans in the South health resource guide meaningfully involves trans community members across the Southern United States to create a much more thorough resource than they otherwise could.

For trans supplies, working with community members was helpful to ensure that the products work with different types of bodies and identities. Kai from Trans Tape, a gender-affirming tape product that helps with body transformation, described the company's process: *"We have models and people we work directly with. So we're able to actually see what it looks like on people's skin tones and how we can try to adjust to make it more encompassing and more inclusive for people."* While working with bodies is different than involving trans community members in other ways such as listening to their feedback and ideas, Trans Tape did both, which made their product even more inclusive.

Before officially launching, Guerrilla Davis described how the creators of Arm the Girls (a self-defense kit for trans women of color) discussed the idea with community members, both in person and on social media.

> *We were doing a lot of events around... art and social justice, and it was at these events we were talking about..., "what do you think about this idea of Arm The Girls?"... These conversations that we had with people, [and] having conversations on our social media platforms, really informed how Arm The Girls came about.*

In this way, community values pervaded the project. Similarly, when developing Jailbreak the Binary, creator Dev was heavily influenced by their trans community on Tumblr. Being involved in trans communities, both online and off, enabled creators like Dev and Davis to understand that their projects were needed, and how their projects could best meet community needs.

One way that some projects from academic contexts attempted to incorporate trans communities in the design process was by constructing a trans community advisory board. Laura Horak, creator (along with Evie Ruddy) of Transgender Media Portal, an online directory of films made by trans people, described,

> *We have an advisory board that's all trans scholars and artists. There's one Black person and one Indigenous person out of six people there, but we're going to reconstitute it majority BIPOC [Black, Indigenous, and People of Color], and also pay the advisory board members.*

Because Horak and Ruddy are both white, and Horak is cisgender, having a trans community advisory board helps to ensure that BIPOC trans communities' priorities and values are emphasized in the project. Trans Women Connected, a technological intervention that used social aspects to increase trans women's knowledge about HIV, similarly employed a community advisory board to guide their efforts. They did substantial work to ensure that the advisory board included racial minorities and also representation from many different US regions, using mostly word-of-mouth efforts to build the network. BA Laris, who coordinated the various aspects of the project, described how the design team involved the board:

> *Essentially, we had one meeting a month, and then they were asked to do one other contribution a month. We had a closed Facebook group where we would post certain things and get reactions, like to images or to content, or asking probing questions around for some of the stories that the [app's educational] activities were being built around. Or they were asked to do special projects, like, "Oh, could you review this, or could you have a one-on-one interview with one of us? We're stuck on this issue. Or could you..." So, basically, we asked them to have two engagement points a month, and then for that, they got a hundred dollars a month.*

While this approach is laudable, from what we could tell from our interview, it sounded like Trans Women Connected involved their advisory board more in smaller decisions (e.g., image choice) rather than larger or more contentious decisions that may actually shape the project's direction. Yet by involving their community advisory board in some decision-making, Laris's team could go beyond their own primarily cisgender thoughts and ideas.

Sometimes, communities could be involved in design and development directly via writing code; open source software makes this possible. Especially with browser plugins, where much of the code is borrowed from other extensions and then tweaked for a particular extension, people from all across the world can easily help out with updates. Willow Hayward, creator of Deadname Remover, described:

> *It's a piece of open source technology. It's just been on the GitHub that whole time. Other people started to participate and help out and fix bugs and just make it better... The last two releases I haven't written a line of code and it's much better than the original version.*

In this way, open source software is a lightweight and helpful way for communities to become involved in technology creation.

In each of these examples, we see how involving trans people and communities in various parts of trans technology design processes improved the technologies to be more aligned with trans needs and challenges.

4.5 User testing and iteration

Iteration is crucial to technology design; nothing is perfect the first time around, and testing with users and communities allows designers to make important changes. cárdenas [16] discussed iterative technology design and how in community-centered design, projects must shift after community input; she urges us not to think of this shifting as a failure, but instead as a way to learn quickly so that the next version of the project will be more aligned with community values. Many of the trans technologies in our research involved iterative design processes, often as a result of conducting user testing or playtesting with trans people and communities.

The creators of trans voice training app Christella VoiceUp told us about their extensive user testing processes with different stakeholders, which resulted in an iterative design process: *"It went through different testing stages, and then changed at different stages, depending on the feedback. The design processes is ongoing... they have to be updated, they have to be renewed, they have to be changed, depending on patient feedback."* Similarly, with Trans Tape, designing the product will *"always be an ever evolving process. We want it to be like we've included everybody."* RKA conducted user testing to help her understand tradeoffs in user interface design, such as how much text and instructions to include in transition resource app Solace, and explored this during user testing:

> *"Do you need explicit instructions? When and where do you need that? And where is more comfortable just to*

> *explore?" So it's having that balance between inviting people to come in, explore, have fun, but also having them feel supported, held, and not just like they're in a world of chaos. So the user testing helped with understanding that balance between fun, exploration, and also structure.*

Rob Eagle described the community-based user testing they employed when creating Through the Wardrobe, especially with four people whose voices and experiences were featured in the exhibition. Eagle spent substantial time with each of these people, during and outside of user testing. They described,

> *It brought me much closer to those four people. It challenged all of us to question ourselves, our assumptions about our identity and everything else. But also made me question, what is good design? What is obvious design? How do you signpost certain things? So I learned a lot in that process.*

By way of close collaboration and user testing with community members, important questions about the nature of design helped guide Eagle through the design process.

Sometimes user testing was informal, such as when Wayne Temple asked his son to test out the browser extension he had built to remove his son's pre-transition name from websites.

> *I had him use it on the home machine... I had him give me feedback. He was maybe eight by that point. So it was more like, "Oh cool..." We put it on all the machines I had here in the house. So anytime he was working on our stuff, we could be assured that he wasn't going to see his old name.*

Though Temple's son did not have detailed design feedback for his dad, the fact that the extension worked well in their home setting was enough user testing needed to ensure that the extension was working as intended.

User testing processes also occur in more wide-reaching trans technology apps, including a prominent queer social networking and dating app. The app's Product Designer, who wished to stay anonymous, described many different ways that the app incorporates user ideas and feedback into their design, which enables them to innovate features in ways that the design team may not have otherwise considered. *"I'm thinking of this specific feature recently that a user suggested in testing,"* the Product Designer described.

> *They were like, "It would be really nice to have an optional tag on a profile if someone is a person of color, or you can break it down even further, you can mark yourself as Black or Asian, your very specific race." And I thought that was an interesting idea... There's having specific filters, so if you just want to search for trans people and you just want more trans people in your life, having some sort of filter system. However, these tags could also be used to abuse. I am curious how to explore a feature like that responsibly. We have to strike a balance between providing our users with an easy way of finding people they have things in common with while also keeping them safe.*

The Product Designer considered this an example of involving users in design processes to potentially enable the technology to move in surprising yet important directions:

> *I think design is literally all about going in ways that you don't expect it to happen. So, I'll do something and I think it's a fantastic idea, and we'll test it with a couple of people and we're like, "We have to start over." And that's actually fun to me because at least I'm knowing that we're getting constructive feedback. Or maybe someone completely ignores it and that's very, very good feedback.*

Listening to users in these ways enables the app to innovate in inclusive ways. The Product Designer stated,

> *I feel like we have just the most helpful users ever. If something doesn't work, we'll know it doesn't work and people will tell us. I used to kind of take offense to that, but now I just realized it's because people really care and value this space and they want to make it better.*

Having users who are invested in a technology's design can make that design better in ways that designers may not have considered, and the above is an example of a successfully deployed app that takes user testing and feedback seriously.

When playtesting trans games, experiences can be much more moving for trans people as compared to cisgender players. Jess Marcotte described their experience playtesting their game TRACES with both groups:

> *Mostly the response from both categories of folk were generally quite positive about the experience, but I think the difference was that for trans folk, they noted... that there was joy and love in the stories that were being told, but also a fair bit of pain. And a fair bit of experiences that I think are common to trans folk, and easily understood, but that point more towards pain. When I had trans folk play it, some of them really loved it, but some of them were like, "this is kind of a sad game in a lot of ways." And what they wanted to share, and something that stuck with me, is that trans experience is not sad and miserable because trans people are trans, but because of transphobia. That's embedded in the culture.*

In this way, playtesting with trans users brought out unique insights about the nature of transphobia, and the ways that games can be a mechanism for understanding the complex nature of trans experiences; joy and playfulness mixed in with pain and marginalization.

These examples show how user testing enabled designers to iterate in ways that involved trans people's user feedback, which made the resulting technologies more impactful by way of incorporating trans experiences.

4.6 Successful design processes vs. successful deployments

An important tension that we discovered is that many of the most successful human-centered design processes we encountered took place in academic settings, and the technology was then not actually

deployed. On the other hand, the technologies that are actually deployed are often not designed with a human-centered approach.

Pereira described the barriers to deploying LGBTrust, noting that he *"kind of"* deployed the app,

> *but it was like a prototype deployment. I had most of these functionalities working so people could ask for help, people could post things, it would appear in the map, and people could ask for any other kind of support and this kind of stuff.*

Pereria was frustrated about not having the resources to fully deploy LGBTrust:

> *I think that in the end, and this is something that really frustrated me at the time, for you to be able to [deploy an app] you need a lot of money, and you need a lot of people working with you...*

Particularly because people would need to trust the app to keep them safe in dangerous situations, Periera wanted to make sure everything worked without any issues. *"And I just couldn't do it by myself. So I couldn't release the app, like in a store for a lot of people to download it... it was kind of halfway there."* Pereira noted that the participants in the study who participated in the human-centered design process were also disappointed.

> *They were kind of frustrated as well, that it didn't go full live. They couldn't really use it in a daily basis. Because it was like a baby from all of us, and I felt that they had a kind of emotional attachments to the project in the end.*

Baeza Argüello's facial prosthetics for exploring multiple Apple ID identities, similarly created in an academic setting, also did not fully deploy to a large public audience. However, the research team was able to deploy the prototypes with a small group of three people who had participated in the design workshops.

> *Those three [people really wanted to] keep developing it to have [their] own, properly designed ones [for themselves]. They came to the studio weeks later after the project, and we did the prosthetics for them. They keep using them. Actually, one of them uses it in the place that they work, they have that facial recognition system, and [they] use [it in] that exact [scenario] that [we discussed].*

Baeza Argüello went on to describe another participant who continued iterating on the prosthetic's appearance with different colors and artistic content to achieve a look that they would wear in everyday settings. For a small group of people, the prototype prosthetics were successfully deployed, and even helped one person resist surveillance technology in their workplace. But despite the usefulness of the technology, deploying on a larger scale was outside of the scope of the project.

Several of the trans tech creators we talked to who had designed their technologies in academic classroom settings similarly did not get a chance to deploy. After their Interaction Design course ended, Flux's creators focused on finishing their degrees and finding employment rather than working on the app further. Starks' safety app U-Signal also has not been deployed yet, though they have conducted more human-centered design research on the app and have redesigned it after finishing the course.

On the other hand, many of the technologies in this study whose creators did *not* employ a human-centered design process have been deployed and are being used by hundreds or even thousands of users. In the Apple app store, one can find Tser, Safe Transgender Bathroom App, Patch Day, and many others, none of which were developed with a human-centered approach. In the Chrome Web Store, one can find True Self, NameBlock, Gender Neutralize, and Jailbreak the Binary, all of which were created within a few hours or days with very little user involvement or feedback.

The trans technologies that we argue would be most impactful for addressing the challenges that trans people face, if deployed, are those that meaningfully involve trans community members throughout the design process so that trans people's lived experiences can influence design every step of the way.

5 DISCUSSION

In Results, we described many different ways of and instances when trans tech creators involved trans people in design processes in some way. Whether this was a full human-centered design process including participatory design sessions, or by incorporating feedback from users as part of an iterative design process, or by way of being trans themselves, human-centered approaches helped make trans technologies usable for a wider range of trans people. We argue that trans technologies can be most impactful when they involve community members; community involvement enables technology to best address trans needs and challenges and highlights how trans perspectives and lived experiences enable a reworking and rethinking of technology design to benefit trans people. Without including trans people in trans tech design processes, designers risk creating systems that either miss the mark in actually helping improve trans people's lives, or in some cases, may actually harm trans people. Researchers and designers can use these results to understand ways to include marginalized communities in technology design processes when designing technology meant to support marginalized populations. By documenting the strength of including trans people and communities throughout all the different phases of design processes, we recommend as much community involvement as possible to ensure that the resulting technology truly addresses community needs and challenges.

This work helps us understand what it means for design processes to be human-centered, and extends prior work that examined human-centered approaches in mainstream contexts, or specific design processes with marginalized groups. Human-centered design has typically been applied and studied in more mainstream contexts [8, 11, 48] rather than focused on marginalization, equity, or justice [18], though newer lines of research have documented participatory approaches aligned with marginalized groups and social justice [19, 29]. While many studies have discussed how design processes work in the context of one study, such as Harrington et al.'s study with Black older adults [30] or Liang et al.'s study with gender diverse young people [37] – which is certainly important – we extend this work by providing an understanding of how users were involved in design processes broadly for a particular marginalized population. This approach allows us to see the wide range of

ways trans people were involved in design processes. Additionally, critiques of human-centered design also often apply primarily to more mainstream design contexts. For example, in the context of a maker incubator in China, Lindtner [38] critiqued human-centered designers' "often short-term engagements" that, rather than impacting systemic change, "function as powerful portfolio pieces for the interventionists themselves."

In the case of trans technology, designers' investments were very different. Because trans tech creators are often trans themselves and embedded in trans communities, their efforts to create technology that helps to address their own and their community's needs are typically less extractive and more focused on addressing community needs rather than simply self-serving (e.g., adding to one's portfolio). In the cases that designs were not deployed, it more often pointed to a lack of resources, time, and sometimes skill needed to take the next step. In cases where substantial change was not achieved, it was because massive systemic changes are needed to address trans discrimination and inequality in the current political environment; we, and many of the participants in our study, are well aware that technology cannot solve the systemic problems that trans people face, but that technology can make small inroads to making trans lives more livable.

The design processes that we described in this work are in many ways unique and different from traditional design processes, in which designers who are outsiders of a community bring participants together to provide input on technology design. First, communities are incredibly important in trans people's lives [24, 39], and often trans tech creators were also part of trans communities. Many trans technology creators were also in community with each other, and were creating technology to address different needs across the trans technology ecosystem. Next, trans technology design helps us to imagine new possibilities for technology that go beyond what already exists – if trans people's needs were already being met, then trans tech creators would not need to create technologies to meet these needs. Trans technology design processes highlight the ways trans tech creators, often in collaboration with community members, question the underlying designs of technologies and rework them to benefit trans people.

It matters that trans people are involved in trans technology design processes because trans people need technological solutions to address some of the challenges they face in the world, and these solutions must actually account for and design for users' needs. Adequately addressing trans needs requires involving trans people in design processes, as many of the participants in our study did. Additionally, trans tech creators and the trans people involved in their design processes provide a unique and valuable perspective on gender and embodiment in technology, and how people interact with technology during and after a major life change.

Despite the empowering and potentially liberatory potential of trans technology, we noted that many of the most successful human-centered design processes took place in cases where the technology was not actually deployed. What does it mean for human computer interaction and interaction design, when the tried and true methods that we teach for technology development are often followed most closely in classroom and academic settings, to build technologies that many times never reach users? Harrington et al. [29] discussed participatory design's potentially harmful nature when communities were asked to help design technology. When considering trans technology design, it may be harmful and extractive to include trans people in design processes when the technologies that are envisioned and designed are never deployed. It can be frustrating and disappointing for trans communities to see the potential of technologies that can help address their needs, but never get the opportunity to use those technologies in practice.

At the same time, many of the technologies that we do see deployed are not built with human-centered approaches at all [46]. It may be that our human-centered methods are not always practical or necessary, especially in cases when people are drawing so much from their own personal experience. For instance, in the case of the True Self browser extension, Temple knew that his son needed this extension, he knew how it should be designed, and his son thought it was "cool" and used it regularly. A human-centered design approach may not have taken him in another direction, or substantially changed the end result. Many trans tech creators' processes echo what is a valid method in HCI called "autobiographical design," defined as "design research drawing on extensive, genuine usage by those creating or building the system" [44]. Participants in this study used autobiographical design processes not for research, but to meet their own needs, yet the self-focused process can be a useful way to use a system in depth and quickly iterate [44]. And yet, without using human-centered design approaches, it could so easily be the case that designers are missing things. True Self works well for a white middle-class trans kid in the Chicago suburbs, with computers at home. Would it also work for a low-income Black trans kid in urban Chicago, who primarily uses computers at the public library? We will examine these topics of privilege and exclusion in our future work.

Here, we push further on the cases we described where designers used human-centered or participatory approaches, or meaningfully involved trans people throughout design processes, and yet the technologies were not ultimately deployed. We see an important gap here, and an opportunity for going further with innovations designed with meaningful community involvement but in settings that do not enable full deployment. Based on our understanding of the gap between trans tech design and deployment, we offer four **suggestions to enable community-based technologies that meet trans people's needs to move towards deployment**, so that their benefits can be experienced by a larger group of people. While these suggestions are described here in the trans context, they could easily be broadened to include technology designed for other marginalized groups, or even innovative technologies more broadly.

1. *Set up programs to bring designs from classrooms and academic research to deployment.* While many universities have technology transfer offices and sponsor entrepreneurial technology events, these do not often reach classroom or academic research settings similar to the ones we described in Results, and may not be the best approaches for trans technology. Students and researchers designing trans technology often are not as interested in building technology, or do not have the means to do so or to connect an innovative technological product with the audience who would benefit from it. In university settings, we could build programs to connect student designers with developers and people more well-versed in bringing designs to market. This would not need to work

within capitalist or profit-driven frameworks, but could also lend itself well to non-profit or grassroots setups which politically align better with many trans tech designers' political orientations.

2. *Set up matching programs for trans tech designers and developers.* In our study, we talked to many trans tech creators who were strictly designers, and others who were also developers. Those trained as designers were more likely to employ human-centered design processes, yet they often did not have the skills, time, or resources to fully deploy what they designed. Further, while many trans people are programmers [1,5], being skilled at coding does not always correspond with having a great idea for something to build, or with assessing community needs for particular technologies. Similar to our idea of connecting designers and developers in academic settings, we could set up a match-making program to align promising designs with skilled trans developers who could build and deploy those technologies.

3. *Set up programs to connect tech creators with community members.* Tech creators may want to involve marginalized community members in design processes, but may not have access to those communities, and traditional participant recruitment platforms do not typically focus on marginalized communities. With community buy-in, a program and/or platform could facilitate valuable connections between tech creators and community members, and ensure that community members receive proper compensation for their involvement.

4. *Make more space for publishing on technology deployment and user studies.* One reason that technologies designed in academic settings are often not deployed is that there is little incentive for academic researchers to deploy systems and maintain them. While many insights often come up in the earlier stages of design processes that are more standard topics of academic papers, it can be quite difficult to get papers published that detail system deployment and user studies post-deployment if systems are not particularly novel. Because insights that take place in technology deployment may not always be novel, and because not all systems are novel, reviewers may be reluctant to accept such papers. Many of the trans technologies detailed in this study were not particularly novel, yet addressed a massive need for trans people. Take, for instance, Erin's Informed Consent Map, a Google map tagged with hundreds of healthcare providers who offer trans medical care on an informed consent basis. A Google map is not novel, and a paper describing this system's deployment would likely not be accepted in an HCI publication venue. Thus, if its creator Erin Reed were an academic, there would be little incentive for her to actually deploy the map. Yet Reed's map has helped thousands of trans people find the care they need, and that should be something that we also care about as academics. We need publication venues like CHI to value systems that matter for people, to incentivize academics to go beyond design to deployment, and further to maintain those systems long-term. Papers describing systems and how people use them can be important even if they are not especially novel from a research perspective. While the lack of incentives for deploying and maintaining systems is an issue across HCI more broadly, in the realm of trans technology design incentivizing deployment could substantially improve trans people's lives.

6 CONCLUSION

In this work, we have described how trans people and communities are involved in trans technology design processes. Unlike many human-centered design processes, trans tech creators were often meaningfully involved in trans communities themselves, and were creating technology to help address challenges faced by trans communities. Trans technologies can have real impact on improving trans people's lives especially when design processes include trans people and communities, because human-centered design processes enable designing for communities' needs. Yet we highlighted a gap that sometimes occurs between trans technology design and deployment. Meaningfully involving trans people in design processes is laudable but is not enough; to realize a future in which trans technology design fulfills its goals of helping to address the challenges trans people face in the world, we need mechanisms to better support human-centered design processes to go beyond design to deployment.

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