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Using Do-It-Yourself Practitioners as Lead Users: A Case Study on the Hair Care Industry

Lead users play an integral part in helping engineers to identify latent needs of customers, and this approach has been used in a variety of ways within the design community. However, despite their close resemblance to lead users, do-it-yourself (DIY) practitioners have not been directly examined by the design community. A seven-step framework is presented where the first four steps resemble a typical design process and the remaining steps are relevant for the approach of identifying DIY practitioners as lead users. A case study from the hair care industry is presented to illustrate this framework. This paper establishes a connection between these two groups of customers and demonstrates how the insights of DIY practitioners, which manifest as latent needs for knowledge, can inspire research for the development of new technologies.
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1 Introduction

Understanding customer needs is an integral part of the design process. A number of approaches to gaining insight into customer needs have been published in the literature [1–4]. Here, we will apply the "lead user" concept to DIY communities.

The lead user concept has been at the core of various studies [2,5] since it was first introduced by von Hippel in 1986 [1]. Two conditions constitute lead users: (1) they experience the need for solutions ahead of the general market and (2) they benefit significantly from realizing the solutions [1]. These conditions facilitate the identification of latent needs of the general market and the creation of innovative solutions. Latent needs are defined as inconspicuous customer needs that may be hard to discover [6] and hard for customers to articulate. On the other hand, Kotler first introduced the concept of "prosumers," which describes consumers that also innovate products by themselves [7], similar to the concept of codesign [8]. Wolf and McQuitty asserted that the best examples of prosumers are the participants in a DIY movement [9]. While the design community has studied the lead user concept [2,4,10–17], DIY practitioners have been overlooked, despite the fact that their characteristics closely resemble those of lead users.

By establishing a connection between lead users and DIY practitioners, this paper will provide: (1) a derivation of a DIY community as a pool of lead users; (2) an illustration of using DIY practitioners as lead users to identify latent needs with a case study from the hair care industry with some initial results; and (3) the introduction of a new type of customer need, the "latent need for knowledge," as a cue to generate important research questions to drive innovation in the market.

2 Background on Lead Users

Lead users are defined as (1) individuals who experience a need before ordinary users and (2) individuals who benefit significantly by obtaining a solution to their need [1]. A number of researchers tested and confirmed the viability of these two conditions for product innovation [3,5,18–24]. Lead users generated more innovative ideas than ordinary users [20], and their evaluations of new products were more accurate than those of product experts because they were aware of both user needs and product trends while product experts' knowledge was often limited to product-related information [25]. Another study reported that, in the long term, a market-oriented approach (addressing latent needs) is more beneficial than a customer-led approach (addressing explicit needs) [26]. Despite its benefits, design approaches based on lead users are difficult to implement because it is hard to identify lead users. It may take several months to recruit lead users [27], and even upon identification, their needs are often limited to niche or high-end markets [2].

Researchers in the design community have made significant contributions to addressing these limitations. Tuarob and Tucker proposed text mining large amounts of data available on social media as a means to discover latent product features [10]. Zhou et al. suggested sentiment analysis and analogical reasoning to identify latent needs from online product reviews [4]. They attempted to overcome the limited capacity for semantic processing of the current text mining techniques. Outside the design community, researchers, including von Hippel, have explored a systematic approach to identify lead users and incorporate their needs into next-generation products and services [1,28,29]. von Hippel also suggested a method for finding lead users by tracing the most knowledgeable people through a series of referrals [30].

Instead of identifying lead users, Lin and Seepersad suggested a method to derive lead users from ordinary users by putting them into extraordinary scenarios [2]. Genco et al. introduced empathic experience design, which simulates lead users' experiences, to generate more original ideas [11]. Vaughan et al. found that the creation of empathic lead users from ordinary users leads to a two-fold increase in the number of latent needs discovered [12]. Using a similar approach, Johnson et al. reported that empathic experience leads to the design of more original product–user interaction features [13].

Other studies have identified lead user needs by using specific demographics. Hannukainen and Hölttä-Otto suggested that studying the needs of disabled users leads to the discovery of latent needs of ordinary users [14]. Judge et al. proposed investigating users from the developing world to elicit latent needs of developed world users [15]. Srivastava and Shu studied Old Order Mennonites, who practice a low resource lifestyle, to gain inspiration for how to inspire the general population to live a more

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Table 1 Comparison between the definitions of lead users and DIY practitioners

Lead users	DIY practitioners
Experience the needs ahead of the general market [1]	Perceive a lack of quality from available offerings [35] Experience a lack of product availability [35] Feel the need for customization [35]
Benefit significantly from the solutions [1]	Benefit economically [35] Experience identity enhancement and a sense of empowerment [36]

environmentally conscious lifestyle [16]. Raviselvam et al. proposed using the elderly as lead users to generate design that equally or better satisfies the needs of the general population [17]. Lai and Shu used DIY practitioners in home improvement as lead users to gain insights on promoting environmentally conscious behavior [31].

In this paper, we will investigate a time- and resource-saving method that predefines members of a particular demographic as lead users who will facilitate the identification of latent needs. Our approach will extend the scope of current studies by defining the participants of a DIY movement as lead users.

3 Methodology

In this section, we first synthesize the literature to show how DIY practitioners and lead users are related. We then present a framework and use it to illustrate how DIY practitioners can be utilized to address the problem in the hair care industry.

3.1 DIY Practitioners and Lead Users. Since the conception of the DIY movement in home improvement, it has been spreading to other areas of people's lives. Market landscapes are rapidly changing with the advent of technologies facilitating this consumer behavior. Three-dimensional printing and the maker movement cater to this market and are expected to disrupt the overall structure of the supply chain and how it has been managed traditionally [32]. The quality of DIY projects is improving, and the required expertise is becoming more and more sophisticated [33]. The DIY approach is expanding its scope to other areas such as law and health care [34]. Recent studies on DIY culture recursively emphasize its potential for providing insights into customer needs and innovation in various industries [9,33–37].

Participants in the DIY movement are exemplary of prosumers, a term first coined by Kotler that describes individuals who not only consume but are also dedicated to producing goods [7]. They are a group of dedicated users who will go an extra mile to make changes to (or often devise creative new) products to meet their needs. They are motivated by (1) relative economic benefits, (2) a perceived lack of quality from available offerings, (3) a lack of product availability, and (4) the need for customization [35]. In addition, the benefits of DIY not only include an economic gain but also an emotional value such as identity enhancement and a sense of empowerment [36].

As shown in Table 1, the DIY motivations align well with the conditions for being a lead user. Furthermore, the lead users frequently act as innovators instead of merely providing information about their needs [5,18,19,21] similar to DIY practitioners inventing their own solutions. Therefore, it is reasonable to state that DIY practitioners and lead users share much of their common characteristics.

3.2 DIY Practitioners and Lead Users as Opinion Leaders. The congruency between the definitions of lead users and DIY practitioners allows to further connect their characteristics. Lead users are characterized by their role as a bridge across cliques/clusters of people, which enables them to get access to a variety of information and overcome communication barriers, thus achieving more creativity [38–40]. This finding is consistent with another observation that stated that lead users contribute to introducing and spreading new knowledge to the community [41]. They exhibit high opinion leadership (i.e., are opinion leaders) and readily adopt and spread new products [42]. Lead users, either implicitly or explicitly, evaluate the value proposition of products and exert bias on the overall attitude expressed in product blogs toward the products [43].

Numerous papers investigating electronic "word of mouth" studied the phenomenon of opinion shaping by influencers within the communities both off- and online [44–46]. Given the fact that DIY practitioners actively participate in knowledge sharing and spreading in the community [37,47], they are also considered opinion leaders.

This opinion shaping and knowledge sharing behavior is one of the reasons why we consider DIY communities as a pool for lead users. Franke et al. reported that a higher degree of lead user characteristics correlate with a higher likelihood of innovation and its attractiveness to ordinary users [20]. Although in general, not all members within a DIY community are necessarily innovators, it is plausible to consider those who innovate and share the knowledge within the community as both DIY practitioners and lead users. Their strong opinion leadership will shape the overall opinions within the community, while active knowledge sharing ensures that these opinions spread throughout the community. This facilitates user-driven innovation and discovery of latent needs. Therefore, the closeness in characteristics of DIY practitioners and lead users is sufficient to treat a DIY community as a pool of lead users, so we can identify latent needs by investigating DIY communities without the need of recruiting lead users.

3.3 Framework for the Case Study. Figure 1 shows the approach followed during the case study. Steps 1–4 illustrate the traditional product research methods used by engineers. Steps 5–7 (in bold) are the unique contributions of this case study that pertain to the utilization of DIY practitioners as lead users to identify their latent needs. This approach is case-specific, and it is highly likely that other approaches will perform better depending on the context of the problem at hand.

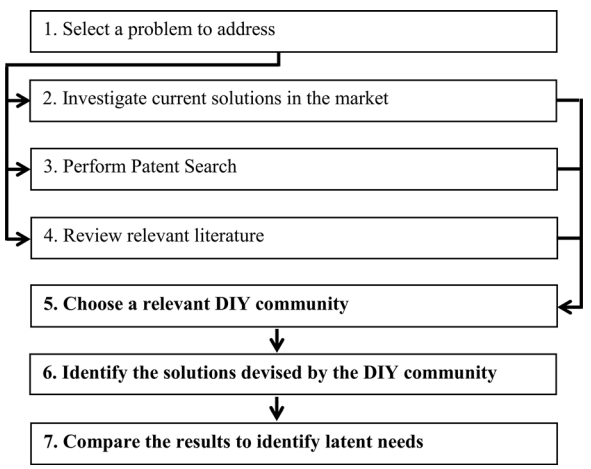

Fig. 1 Method used to identify latent needs for knowledge among DIY practitioners

In the initial step, a problem was selected and its significance was elaborated, similar to what is done during the problem definition phase in design. Steps 2–4 were performed simultaneously, focusing on identifying potential solutions among products already on the market, patents, and the literature. In step 5, a DIY community with potential lead users was chosen making sure that its characteristics closely align with those of DIY practitioners and lead users. In step 6, solutions developed by the DIY community were investigated. In step 7, knowledge gaps were compared to elicit latent needs.

4 Case Study

The following case study illustrates how DIY practitioners can be utilized to discover the latent needs of ordinary users. It is based on prior work of the authors [48] that examines challenges of members from the natural hair community (NHC), which is suitable for illustrating the framework.

4.1 Background on the Case Study. The NHC is a large DIY hair care community that caters in particular to the needs of women of African descent. The "natural hair movement," which the NHC revolves around, encourages people of African descent to refrain from using chemical relaxers and to wear their hair in its natural state. In doing so, they had to face challenges to take care of their particular hair type: extremely curly and naturally dry [49]. This introduces extraordinary use scenarios of the existing hair care products and makes women of African descent lead users for hair care products. Extraordinary use scenarios exist when customers use products in unconventional ways and under extreme conditions [2].

Through anecdotal evidence, the authors are aware of other ethnic groups with curly hair that have expressed similar concerns. However, women of African descent will be the focus of this study due to the prevalence of public information about their challenges and efforts to resolve them. Often, biracial and multiracial populations with darker skin and very curly hair are also referred to as African Americans without distinction. In the following, "people of African descent" will be used as an inclusive term for all these populations for clarity and consistency.

4.2 Significance and Relevance. The significance of the problem is evident considering the size of the general U.S. hair care market targeting populations of African descent; the market amounted to $774 million in 2014 [50], excluding main stream brands, online sales, among other purchases. It was estimated that the grand total of all hair-related purchases amounted to half of a trillion dollars [50], which comprises nearly 40% of the disposable income based on the projected spending power of African Americans in 2014 [51].

4.3 Select a Problem to Address. During informal conversation, NHC members expressed a problem related to hair damage caused by heat, also known as "heat damage." Heat damage is the term used to describe curly hair that permanently loses its original curls as a result of heat application. It includes formation of cracks on the cuticle [52], keratin denaturation [53,54], loss of proteins, change in color [55,56], increased porosity [53], and reduced mechanical properties [57]. As a result of heat application, hair shows loss of natural curls, reduction in luster, and increased dullness and dryness. YouTube also verifies the interest level in this problem. When doing a search in YouTube using the term "heat damage on natural hair," approximately 211,000 videos and channels were found. That is 57,000 more videos and channels posted on this topic since it was first documented in 2015 [48].

4.4 Investigate Current Solutions in the Market. The main source of heat damage expressed by NHC members comes through the use of flat irons. Flat irons are widely used to temporarily reconfigure curly hair. One of the problems with flat irons is the lack of consistency and transparency of the information shared with customers. For instance, when reviewing ten different flat irons spanning low to high price ranges, the temperature recommendations varied based on vague descriptions of hair (fine, course, and medium) as shown in Table 2. They neglect to mention other properties of hair. In addition, the manual made no mention of heat damage as a potential risk for use of the device.

Similarly, heat protectants are a commercially available product that must be applied to the hair to mitigate the detrimental effects of heat. However, similar to recommended temperatures for using flat irons, the scientific evidence of product claims was not fully validated. Some contradicting results will be discussed in Sec. 4.6.

The flaws of current solutions in the market are among the sources of inspiration for the solutions generated by DIY practitioners that will be discussed in Sec. 4.8. Both flat irons and heat protectants issue a number of claims that do not explicitly address heat damage and are not found in the scientific literature.

4.5 Perform Patent Search. Patents were searched with keywords such as "heat" and "heat protection." A total of 17 patents directly relating to protecting hair from heat were reviewed. The suggested solutions were categorized by whether they related to the material properties of the flat iron plates, or whether they were based on chemical products.

According to some of the patents, using appropriate materials can mitigate heat damage. For example, some patents claimed that ceramic or tourmaline plates emit anions and far-infrared when heated and that these features can strengthen and preserve hair's integrity [58,59]. However, the effects of anions and far-infrared on human hair have not been scientifically examined in the patents, or scientific journals.

Other patents claimed that certain material compounds help to protect hair when topically applied. Such compositions include tourmaline-based agents, polymers, surfactants, and hydrolysates. There are studies that empirically proved the effectiveness of these compositions [53,56]. However, the tradeoff between styling efficacy and the degree of heat protection has not been scientifically established. This is important because if more heat needs to be applied to achieve satisfactory results in the presence of protective agents, such agents become counterproductive.

In addition to these two types of patents, there were two patents that claimed to adjust temperature settings on flat irons according to the moisture content in hair fibers [60,61]. However, the current technology only allows measurement of moisture content in hair fiber by observing the change in the weight of hair fiber under absorption/desorption processes [62], which cannot be done during flat ironing; thus, the reliability of the said technologies introduced in the patents is questionable unless otherwise more rigorously justified.

4.6 Review Relevant Literature. Existing literature offers a fundamental understanding of how heat affects the microstructure of keratin [63,64]. More relevant studies using a curling iron and flat iron were performed as well [53–56,65,66].

The detrimental effects of heat were measured using various metrics: increased heat reducing tensile properties of hair [57], exacerbating protein decomposition, causing color changes [55,56], and inducing cracks on the cuticle, which is the outermost layer of hair fibers [52]. The advantages of using hair care products to protect against heat damage were empirically examined by observing mitigated changes in the metrics used previously [53,56,65]. Harper et al. measured heat styling efficacy with the rate of shape retention [66]. The results indicated that the efficacy of heat styling ceases to increase for temperatures above 100 °C and adverse effects were recorded beyond 200 °C. Dussaud et al. explored the gradual loss of curl pattern with heat straightening

Table 2 Summary of a flat iron type, price, and recommended temperature range according to the hair type for five select manufacturers

Manufacturer	Flat iron type	Pricing[a]	Hair type	Temperature setting (°F)	Notes
1	Ceramic	High	thin/fragile	300–350	No frequency recommendation
			fine	350–390	Hair care product recommendation
			Normal	375–400	Detailed instructions
			Wavy/curly/permed	385–400	Mentions that hair should be fully dried
			Kinky/coarse/thick	400–420	Electrical and burn warnings
2	Titanium	Medium	Fragile	240–265	No frequency recommendation
			Thin	265–305	Hair care product recommendation
			Normal	305–350	Electrical and burn warnings
			Wavy	350–370	
			Coarse	390–450	
3	Argan ceramic	Medium	Fragile	225–275	No frequency recommendation
			Thin	275–315	No hair care product recommendation
			Normal	315–345	Electrical and burn warnings
			Wavy	375–415	
			Coarse	415–450	
4	Ceramic	Low	Thin	Low	No frequency recommendation
			Normal	Medium	No hair care product recommendation
			Thick	High	Limited instructions
					Electrical and burn warnings
5	Argan oil infused ceramic	Low	Thin/delicate/easy-to-straighten hair	Low	Limited instructions
			Average to thick/treated hair	Medium	No mentioning of hair care products
			Thick or wavy hair	Medium–high	No frequency recommendation
			Hard to straighten hair	High	Electrical and burn warnings
			Very resistant hair	Maximum	

[a]Pricing: Low (less than $50), medium ($50–149.99), and high (more than $150).

[54]. However, the result was limited to systematic reproduction of general knowledge regarding the loss of curl without providing additional insights into the issue.

The hair samples used across all studies were straight except for one; thus, the studies focused more on the issues encountered by people with straighter hair, and hence the use of a curling iron rather than a flat iron. The one study investigating a flat iron depicted the loss of curl by heat as an alternative method for permanent straightening [54], which is contrary to the interest of the members of the NHC; they seek a temporary straightening method that will not cause any permanent changes to microstructure or shape of their hair. None of the academic work seems to address the current needs of the community.

Some studies contained results that contradict the claims of products in the market. A water-based heat protectant spray was found to exacerbate the adverse effects of heat as opposed to mitigating it [65]. Also, nonwater-based heat protectants were effective only if multiple layers of coating remain deposited without being washed out for an extended period of time. This is not reflective of the actual service scenario of the product because heat straightening most commonly follows washing one's hair. Furthermore, another study concluded that silicone-based heat protectants showed no significant results in protecting hair [54]. The results of the literature review show that there is a lack of research devoted to study heat damage to curly hair types.

4.7 Choose a Relevant DIY Community. We chose a variety of sources to gather information. An online black hair care blog[2] was our primary source. This website focuses on the sharing of information among women, largely of African descent, on managing their hair in its natural state. This group satisfies the definitions of both DIY practitioners and lead users. We also examined some YouTube video tutorials from prominent members of the DIY community about heat damage and other related heat styling topics. Representative examples can be viewed here.[3]

The group members experience the need for solutions ahead of the general market—in this case, the care of very curly hair. Population trends and research predict that within the next 100 years, there will be an increase of hair types with low to medium curls, and a decrease in straight hair and extremely curly hair [67] because of an increase in interracial relationships. The multiracial population in the U.S. comprised 6.9% in 2015, which is approximately 22 million people [68]. The Census Bureau projects it to triple by 2060, which will be approximately 66 million. Also, while Native Americans (prone to have wavy hair) are a predominant multiracial group, in 2013 biracial black and white (prone to have very curly to coily hair) comprised 36% of the mixed-race babies [68]. Therefore, addressing the current needs of people with very curly hair prepares the industry to meet the demand from the increased number of people with curly hair in a future. Also, they experience extraordinary use scenarios of current hair care products and appliances [2]. Many of the group members experience premature breakage of hair caused by irregular cross-sectional shapes of the hair introducing weak points at twists and increased brittleness caused by inherent dryness [49]. These properties, coupled with the use/misuse of appliances and/or hair care products [69,70], place them at the leading edge of the problem that ordinary users have not yet experienced.

The group members will also benefit significantly from new solutions. They are part of the NHC because they try to follow a healthier lifestyle, including maintaining a natural hair texture, supporting children's wearing natural hair, and salvaging the time and energy spent for heavy grooming practices including straightening [71]. Therefore, innovation that leads to more effective and efficient hair grooming will benefit this group both emotionally and economically. In conclusion, the NHC can be seen as a pool

[2]NaturallyCurly.com

[3]https://www.youtube.com/watch?v=UO85s9yh8Vw, https://www.youtube.com/watch?v=cXBnEJ0LHeA

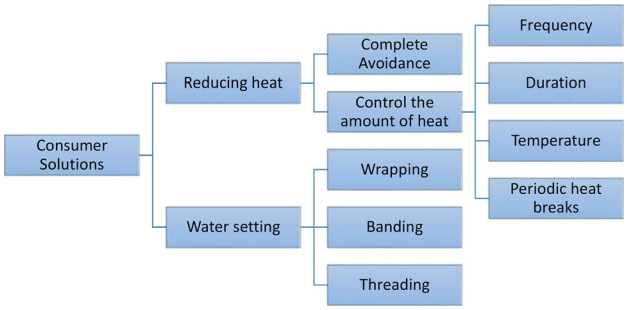

Fig. 2 Solutions/alternatives adopted by customers to mitigate/avoid heat damage when straightening hair

of lead users who can reveal latent needs for hair care industries in the long term.

4.8 Identify the Solutions Devised by the DIY Community. A qualitative analysis was conducted on the blog entries in the NHC. A search using the keyword heat returned approximately 130 out of 7,400+ articles. Of those, 78 articles were either directly or indirectly relevant to heat damage and suggestions for recovery and prevention. In summary, the following customer needs and solutions were extracted: a solution for temporarily reconfiguring the hair shape while minimizing the detrimental effects of heat, such as increased dryness, damaged cuticles, and permanent loss of curls, and a solution that can be repeated on a regular basis.

Not all members from the NHC desire to alter their hair shape/citehahn2015. For those that do, there were two main approaches they took to address the problem (see Fig. 2). The first approach was to reduce the use of heat by either decreasing the temperature setting or decreasing the duration and frequency of heat application, or a combination of both. As an extreme form of minimization of heat usage, practitioners completely avoided heat. One of the problems with the first approach was that heat reduction affects the efficacy of straightening. In this case, one could either refrain from styles that require straightening or adopt alternative ways to achieve a straightening effect. Another approach was the use of water setting methods to achieve a straightening effect. This method exploits the breaking and reformation of hydrogen bonds within the hair fibers with the absorption and desorption of water. The three most common methods identified were threading, banding, and wrapping methods [72–74]. The disadvantage of these methods was inferior straightening efficacy and yet greater effort and time required. One member of the DIY community presents a tutorial showing how to use an IR thermometer to determine the actual temperature coming out of her blow dryer and flat iron in an effort to style her hair while avoiding heat damage. She fits into the "reducing heat category" through controlling the temperature and taking periodic heat breaks. However, the results are not generalizable and only represent what may work for her hair type.

4.9 Compare Results to Identify Latent Needs. The existing solutions discovered in the four areas (i.e., existing products, patents, literature, and DIY solutions) do not satisfy the needs of users: the need to understand how to achieve a straightening effect without causing permanent damage to one's curl pattern across all various curly hair types. First, the instructions for heat appliances are ambiguous, and their credibility is questionable. Heat

Table 3 Comparison between the definitions of lead users and DIY practitioners

DIY Behavior	Reason	Latent needs
Avoidance of heat	Lack of knowledge about heat Concern for hair health	Fundamental understanding of the mechanism of heat in human hair
Engaging in more laborious method for straightening (water set)	Persisting need for hair straightening	Practical knowledge that provides a concrete link between the degree of heat damage and how heat is used

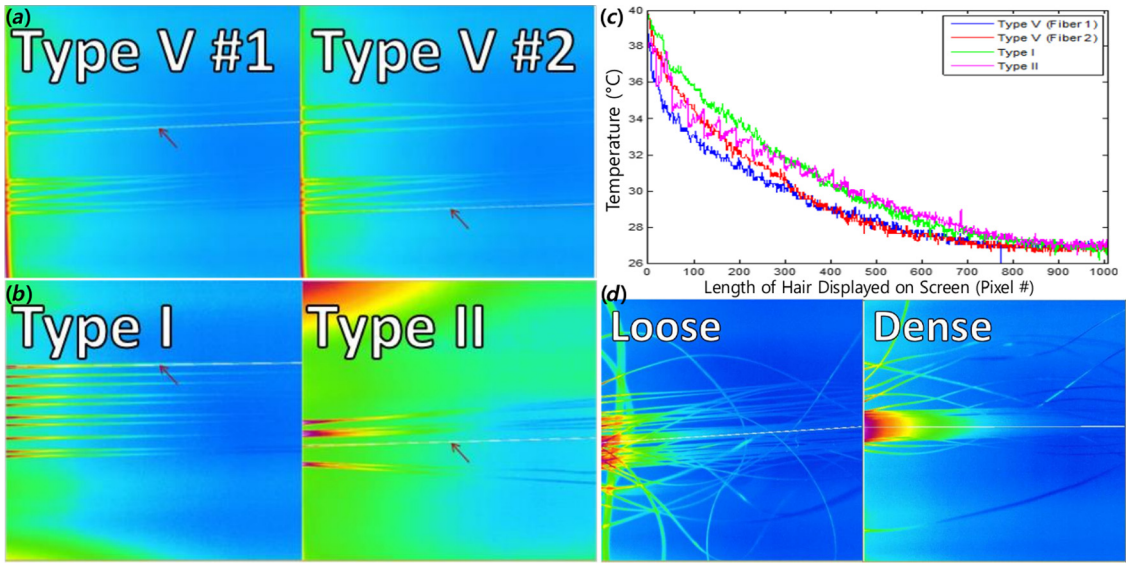

Fig. 3 Two-dimensional thermal maps of hair samples to which heat was applied by a flat iron from the left edge. (*a*) Thermal maps of single strands of Type V hair. (*b*) Thermal maps of single strands of Type I and II hair. (*c*) Temperature profiles of hair strands indicated by red arrows in (*a*) and (*b*). (*d*) Thermal maps of differently packed bundles of Type V hair. In all thermal maps, red indicates high temperature, and blue indicates low temperature - room temperature in this case.

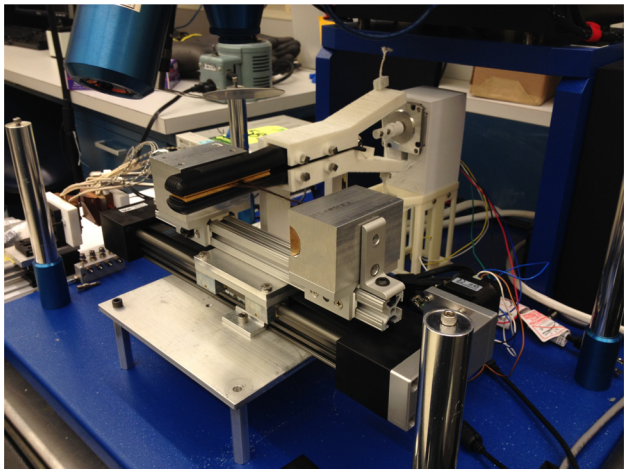

Fig. 4 An automated flat ironing system that simulates flat ironing by clamping down on the hair and automatically translating along the length of the hair fibers

protectants also raise similar concerns. Likewise, claims made by patents are unreliable. Current literature does not address the customers' problem. Finally, the solutions of the DIY community are effective at mitigating the degree of damage but yield an inferior straightening effect; other solutions are not generalizable. Table 3 summarizes the DIY behavior observed and the latent needs that pertain to it.

An initial attempt to address the two research questions was made, and the preliminary results were published [48]. To address the first latent need, three types of hair, straight = Type I, slightly wavy = Type II, and moderately curly = Type V [75], were investigated in terms of their behavior in response to heat application. Figure 3 shows the preliminary results of the investigation. It was found that the thermal conductivity of hair varies across hair types, in fibers within the same hair type, and depending on the density in which hair is bundled together. Further investigation is to follow to confirm the difference in the thermal properties across hair types. To address the second latent need, an automated flat ironing system was fabricated (Fig. 4) to simulate a flat ironing procedure while carefully controlling crucial variables and establish a predictive model that will forecast the onset of natural curl loss as well as structural deterioration of hair. This model will assist in the future development of products that address the specific needs of the customers.

5 Summary of Case Study Results

From the case study presented, we were able to identify two main latent needs: (1) the need to understand the underlying mechanism of heat on human hair and (2) practical knowledge that connects the relationship between the degree of damage and the amount of heat used for better decision making. These needs do not directly translate to product requirements but provide a foundation for the development of new products. We propose to name these particular needs as the "latent needs for knowledge." Similar to direct observations and ethnographies, viewing blog entries and YouTube video tutorials developed by DIY practitioners revealed these latent needs and their methods for addressing them. Thus, it is possible that text mining would not have revealed these latent needs due to the limitations of databases that can understand nuanced text communication [76].

There are some limitations to the data sources of the case study. Online blogs and forums may contain information regarding lead user preferences [43]; however, geospatial data are not necessarily available, and it is difficult to verify heterogeneity of the information [10]. Such a problem may be minor for the case study presented in this work, but could be a bigger problem in other cases. Utilizing online DIY communities that have capacity to organize their members geospatially may eliminate the problem. The use of online social network services is a good example as suggested by Tuarob and Tucker [10].

6 Conclusions

The paper suggests that DIY communities may serve as a pool of lead users by drawing the connection between the definitions of lead users and DIY practitioners. A seven-step framework was presented where the first four steps may be found in typical design processes and the remaining three steps were based on considerations from the DIY community. We presented a case study from the hair care industry, specifically those from the NHC to illustrate how DIY practitioners can be used as lead users to extract latent needs. In entrepreneurship and design, opportunity recognition [77] and problem scoping [78,79] are as important for designers as are the resulting artifacts that they create. Incorporating DIY considerations into the design process can help designers with opportunity recognition and problem scoping in a unique way. Tools such as the customer discovery process and business model canvas used in lean startups [80] may provide an additional approach for understanding customers and discovering unexpected insights from them.

The usefulness of the framework is limited by the number of DIY communities available for the problems to be addressed. In other words, if there is no DIY community relevant to the problem, then the framework need not be used. In addition, future work may involve testing the framework in other DIY contexts. The DIY trend is emerging in various sectors including healthcare, fashion, and automotive [33,34], and more DIY communities are expected in the future. Democratization of knowledge [81] and democratization of technology [47] will accelerate this phenomenon. Recent studies on DIY culture repeatedly emphasized the insight into customer needs that can bring innovation to the industries [9,33–37]. Because DIY practitioners exhibit characteristics identical to those of lead users, the finding should offer researchers within the design community new opportunities and ideas for future innovations.

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