

What is in the Cards: Exploring Uses, Patterns, and Trends in Design Cards

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ABSTRACT

Card-based design tools—design cards—increasingly present opportunities to support practitioners. However, the breadth and depth of the design card landscape remain underexplored. In this work, we surveyed 103 design practitioners to assess current usages and associated barriers. Additionally, we analyzed and classified 161 decks of design cards from 1952-2020. We held a workshop with four experienced practitioners to generate initial categories, and then coded the remaining decks. We found that the cards contain seven different types of design knowledge: Creative Inspiration; Human Insights; Material & Domain; Methods & Tooling; Problem Definition; Team Building; and Values in Practice. The content of these cards can support designers across design stages; however, most are intended to support the early stages of design (e.g., research and ideation) rather than later design stages (e.g., prototyping and implementation). We share additional patterns uncovered and provide recommendations to support the future development and adoption of these tools.

CCS CONCEPTS

• **Human-centered computing** → **HCI design and evaluation methods; Systems and tools for interaction design.**

KEYWORDS

Card-based Design Tools, Design Cards

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1 INTRODUCTION

Design cards have long been presented as valuable tools to support HCI and design work. The popularity of design cards stems from these tools being “simple, tangible and easy to manipulate” [35], and that they are an “approachable way to introduce information and sources of inspiration as part of the design process [53].” A paper published in 2019 has found that more than 150 of such card-based tools exist [46]. These cards have been developed by both academic researchers and industry practitioners. Some prominent examples of these cards include the IDEO Method Cards [28], the Envisioning Cards of the Value Sensitive Design Lab [24], and the Design with Intent toolkit for influencing user behavior by design [32]. In addition to serving as tools to support design practitioners with their work, design cards can also be used as artifacts to support the translation of academic insights into design practice [15]. This includes the use of cards to communicate frameworks [e.g., 34], theories [e.g., 10, 29], and general research findings [e.g., 21]. Design cards continue to be of interest to the CHI community. The most recent CHI proceedings (2022), for example, presented a set of design cards to support designers’ reflection around technology acceptance (a best paper award winner) [42], and another set of cards to support the design of emergency medical services [47]. These examples demonstrate the promise of the card-based tools in not only deepening knowledge and introspection around design, but also enhancing practice.

However, while design practitioners may have heard of design cards, they are unlikely to be aware of the breadth and depth of offerings that exist today. Many practitioners that we have talked to both prior and during this work could only recall a few decks of design cards and were surprised when told that there exists more than 150 different decks. This lack of awareness is further complicated by the fact that the form and content of design cards have continued to evolve, with new design insights and sources being materialized in different card formats. This limited perception and understanding of what design cards have to offer seem to pose critical barriers in the adoption of these tools, raising a number of questions. What insights are actually embedded in existing design cards? How can they contribute to the design process? When should they be used? What are new trends in design cards and how have these tools changed over time? Without a clearer understanding of the design cards landscape, knowing when to apply them and harnessing the knowledge in practice is difficult. This lack of clarity

not only limits the use of these potentially valuable design tools, but also raises doubts about the efficacy of these cards as translational artifacts to help communicate valuable insights from research.

Thus, to demystify the current and changing landscape of design cards, we began with a local survey of 103 designers based in Taiwan. We primarily asked them about their exposure to and use of card-based design tools. We found that these designers had limited experience with using design cards and identified three key barriers to using these tools: (1) Perception of insufficient value in the contents of the cards; (2) High costs associated with obtaining and using the cards; and (3) Lack of structural support or norms to use these cards in the workplace. After conducting this survey, we conducted iterative coding of 161 design card decks, where we found that existing cards contain seven different types of design knowledge: (1) Creative Inspiration; (2) Human Insights; (3) Material & Domain; (4) Methods & Tooling; (5) Problem Definition; (6) Team Building; and (7) Values in Practice. We also found that while design cards have been developed to support work across all phases of design, most are configured to support ideation. Meanwhile, the fewest number of card decks support implementation work. Our analyses further confirms a growth in design cards and changes in content (from creative inspiration and methods to more domain specific insights, e.g., AI) over time.

Our findings offer three contributions. First, our analyses of design cards builds on existing research on classifying design cards and identifies insights contained within existing cards; this contributes to a richer understanding of the design card landscape, helps distinguish offerings in relation to one another, and can support practitioners in identifying which tools to use in specific contexts. Second, our analyses highlight trends and patterns in current design card development, and suggest opportunities for future research and development of tools to support design. Third, we provide empirical data on the current use of design cards in practice, suggesting potential mismatches between existing offerings and the needs of practitioners. All together, this updates and advances collective knowledge of design cards.

2 RELATED WORK

Card-based design tools—design cards for short—are intended to assist and provide structure to design processes. They are often used to facilitate creativity and stakeholder engagement [30], and they achieve this by providing inspirational images, generative prompts, or theories bundled into tangible and applicable material-based resources [10, 27]. However, due to the increasing array of offerings, it is difficult to provide a more specific definition for the tools [11]. A variety of design card decks have been developed to abet a diverse set of designerly needs across topics and situations. They have also been designed to be used in a variety of settings, such as freelance designers working in silos, design teams in collaborative sessions, and to engage with clients or users [50]. Design cards may also come in many different forms. Although design cards have largely been defined by their tangibility and physical forms reminiscent of playing card decks [26], there are now a variety of digital decks hosted on the web and not limited to the materiality of physicality.

Several studies have been conducted to examine the usefulness of card-based design tools. They generally suggest that these tools

can support creativity [35], facilitate “inspiration, organization and communication of ideas” [13], as well as offer useful bits of knowledge or information [40]. However, these published studies on design cards have focused on the use of only individual sets of cards, and are often conducted in controlled settings. This leads to an important question about these tools: are these cards actually used in practice? If these potentially valuable design tools are not utilized in practice, what are some key barriers to adoption? Empirical data on the adoption of these design cards by practitioners is critically needed to understand how these tools can realize their full potential.

One potential barrier to the adoption of these tools is the lack of awareness and knowledge of what is offered in these cards. As noted by Aarts et al., while new cards are regularly introduced by design researchers (and practitioners), “little information can be found that guides future designers as potential users of such design cards in identifying such cards and selecting the ones that are most fitting for their specific design challenge [4].” Thus they, and some others in recent years have acknowledged the need to consolidate and systemize collective understanding of the design cards.

One of the first of such analyses was a review of 18 sets of design cards by Wölfel & Merritt published in 2013 [53] to analyze how design cards might benefit designers. They suggest that the cards can be categorized along five design dimensions: (1) intended purpose and scope of use; (2) duration of use; (3) methodology; (4) customization; and (5) formal/material qualities. Through their clustering activity, they further categorized the purpose and scope of use of the cards into three types: (1) Generalizable; (2) Participatory/Customizable; and (3) Context Specific. They also identified four groups for the duration of use dimension: (1) Anywhere/Anytime; (2) As needed; (3) Beginning of; (4) Specific point. While these groupings provide good basis, a number of questions have been raised about the classification established in this work [4, 46]. For example, should the “general tools” grouping be more fine-grained and have separate classifications for methods and ideation? Does participatory design warrant its own category and are some of the decks coded under participatory about participatory design or more just generally about fostering collaboration? How does “anytime” use differ from “as needed”? Further, this work only assessed 18 sets of cards, raising limitations about the robustness of the categories, breadth of analysis, and generalizability of the work as over one hundred other cards exist.

To address these limitations, Roy and Warren followed-up with a study of 155 card decks and categorized the main purposes of the cards into: (1) Systematic design methods and procedures; (2) Human-centered design; (3) Domain specific design; (4) Creative thinking and problem solving; (5) Team building and collaborative working; and (6) Futures thinking [46]. However, one may also question these categories similar to Roy and Warren’s own critique of Wölfel & Merritt’s categories. For example, are systematic design, human-centered design, and creative thinking and problem solving three distinct enough categories to clarify the landscape? Further, these categorizations may lack sufficient granularity to help communicate to designers when or why they should use these cards. For example, human-centered design alone encompasses many design activities and cuts across various phases of design; simply categorizing a deck of cards as supporting human-centered

design does not help make clear why and when one should use them. This is perhaps why within the same paper, Roy and Warren also developed five categories for how the “cards are supposed to work”: (1) Prompt and stimulate creative thinking; (2) Summarize good design practice, know-how or information; (3) Summarize design methods; (4) Provide concepts for specific design problems or domains; and (5) Provide checklists to aid specific design tasks. But it is unclear how their two sets of classifications were separately developed or how they relate to each other. All this limits our understanding of the current landscape of design cards and makes it difficult to differentiate among and explicate the potential usefulness of these tools to practitioners.

With a slightly different focus, Aart’s et al. 2020 paper sought to characterize the design space of the cards [4]. In coding 32 card sets, they explored 10 dimensions of the card designs, such as clarity, consistency, datedness, attractiveness, and more. Of particular relevance to this work is their coding of the purpose of the cards, and the design activity where the cards may be applied. Like Wölfel & Merritt, they ended up with high level categories for these dimensions. For purposes of the cards, they grouped the cards into (1) General; (2) Specific; and (3) Methods. For design activity where the cards may be applied, they grouped the cards into (1) Brainstorming/Ideation; (2) Conceptualization; (3) Requirements; and (4) User Validation. These high level categories may also not be granular enough for designers seeking appropriate cards for their needs. Further, as design cards have evolved over time, one open set of research questions relates to the changes in patterns and trends over time. What types of cards are most prevalent? Have the content of these cards changed over the years as new ones have been introduced? Exploring these questions, we argue, can offer us a more thorough understanding of the design cards landscape and offer insights on how to improve these tools moving forward.

3 SURVEY EXPLORING THE CURRENT USE OF DESIGN CARDS

We began with a survey of designers in a local design community, Taiwan, to identify usages and barriers to adopting card-based design tools. Per background on the site of our survey, Taiwan has an active UI/UX design community. The regional Interaction Design Association (IxDA) chapter was founded in 2010 and has held 70 events since its inception that have attracted more than 4,000 attendees (<https://www.ixda.org.tw>). Another local group, Taiwan User Experience Professional Association (UXTW), was founded prior to that in 2005, and has had over 30 events with more than 3,000 attendees (<http://www.uigathering.org>). Along with the growing number of design organizations, many designers in Taiwan have also studied and practiced around the globe namely in Europe and the US. Taipei, the capital of Taiwan, has also recently been recognized by the World Design Organization (WDO) as a leader in global design (<https://wdo.org/programmes/wdc/past-cities/>). Two of the authors are connected with this local design community, which made it a rich site for survey research. Like any sample, there are factors to consider in the generalizability of local survey findings across regions (as we revisit in the limitations section). Nonetheless, this local community offers an active group of practicing designers

whose responses provide a valuable glance into the use of design cards in practice.

3.1 Methods

Our survey included multiple-choice questions as well as Likert scale and open-ended questions to assess practitioners’ prior experiences and needs surrounding design cards. The questions were structured into five key sections: (1) Background information about the design practitioner; (2) Design work experience in practice; (3) How the participant learns about design; (4) Barriers to learning design; and (5) Current usages and general needs of card-based design tools. The questionnaire took about 10-15 minutes to complete. Each participant was entered into a drawing to win one of three vouchers (each worth \$17 USD) and was provided with a survey report after completing the entire survey. We recruited the participants from three online design communities and received 107 responses total. We excluded four invalid responses since three participants’ work was not sufficiently related to design and another participant had only worked as an intern rather than as a full-time design practitioner.

Our sample included design practitioners with a range of experience: 18% of participants had less than a year; 36% had 1-2 years; 17.5% had 3-4 years, 14.5% had 5-6 years; 5% had 7-8 years; 2% had 9-10 years; and 7% had over 10 years of experience. This wide of a range is useful because design cards are intended not only to support experienced practitioners, but also, importantly, junior designers and recent design students who may have more to learn from the knowledge bundled into decks and be able to provide insight on usage in design education. In terms of their roles, most participants identified as a UI Designer (23%) or Design Manager (24%). Design Manager in this context includes Project Manager, Product Manager, Design Lead/Manager, Director/Founder, and Freelancer. The breakdown of other roles was: UX Designer (20.5%); Design Researcher (15.5%); Product Designer (14.5%). Among these participants, about half (49.5%) worked at a company’s internal design department and the other half worked at either a startup (37.9%) or consulting agency (12.6%). Almost all participants (93%) were based in Taiwan and the rest (7%) were located overseas.

3.2 Results

3.2.1 Design Knowledge Seeking. In the questionnaire, before asking about design cards, we first inquired about how design practitioners generally improve their knowledge about design practice. Among those surveyed, 59% of participants mentioned that they actively seek out the latest knowledge and skills related to design. Additionally, 40% of participants said that they accrue the latest design knowledge or skills on an as needed basis. We also asked what resources they use to find design-related knowledge including insights about users. We found that on a Likert scale ranging from strongly disagree (1) to strongly agree (5), the main channels for acquiring design and user-related knowledge were: free online resources such as Medium, blogs, and other news columns (4.35); employee training and onboarding materials (4); books (3.85); paid courses either online or in-person (3.55); and lectures or seminars (3.55).

3.2.2 Current Usages of Design Cards & Barriers. Among 103 participants, only 18 of them (17%) reported that they had prior experience using design cards in practice. When we asked participants about the contexts in which they had prior experience using these tools, the majority reported using them at design workshops (52.2%). They also shared using the cards in the workplace (30.4%) as well as in educational settings for both learning about design and for teaching purposes (17.4%). Participants also reported using design cards as tools for engaging stakeholders at workshops for co-creation and co-design processes. As one researcher with experience using a multitude of design cards shared: “These cards are usually used in workshops with users, experts, and designers to co-design.” This summarizes contexts of use.

Outside of the 18 participants who had used design cards in practice, less than half of the participants (43%) indicated that they had heard or knew about design cards prior to the survey. From these participants, we also coded their reported barriers and generally clustered them into three categories. First is a set of barriers related to the content of the design cards. Most of the participants said that they did not use the cards because the cards did not match their work requirements or present utility in terms of the practical work that they needed to accomplish. Furthermore, nearly one fifth (18%) of the responses noted that it was unclear how to actually apply these cards in practice. The second barrier is associated with the cost of use. About another fifth (21%) of the responses among the 44 participants mentioned that it was too costly to use these cards. This included costs of time needed to identify appropriate cards to use, costs of acquiring the cards (either to figure out where to download or the retail costs), and costs associated with learning how to and then applying the cards. Finally, the third set of reported barriers (9.1%) reported that their company or design team did not have any norms in place for using and applying design cards on the job.

However, one important thing to consider in interpreting these reported barriers is that it is possible that many participants may not be aware of the array of cards available. This is evident by the fact that when asked to recall specific design card decks, we only got two specific responses: IDEO Method Cards [28] and Bootleg Method Cards [8]. This lack of awareness of available design cards may have contributed to the lack of perceived value of these tools. It may be that the designers’ needs can be supported by existing cards, had they known more about the current landscape of design cards. Thus, as part of our work, we turned our attention to analyzing the content of the design cards to better understand patterns and trends in existing cards.

4 CODING OF DESIGN CARDS

We employed an iterative process where we analyzed the content of 161 sets of design cards in total, focusing our analyses in terms of *what* insights are contained in these tools and *when* the contained insights can be utilized in design processes according to practical phases. Our coding process involved a workshop with experienced practitioners to form a set of codes based on an initial subset of 42 sets of cards. This workshop was followed by a second phase of coding among co-authors to robustly categorize the overarching array of 161 tools.

4.1 Selection of Design Cards

We started our process by collecting the design card decks to be analyzed. We began with the set identified in Roy and Warren in 2019 [46], which expanded on the set of 18 decks examined by Wölfel and Merritt in 2013 [53]. While Roy and Warren coded 155 decks, according to their appendix, there were only 135 distinct rows as some of them were part of the same overall kit (e.g., 18 of the decks were part of the MethodKit [12]). We then expanded on the 135 with additional decks identified by Aarts et al. [4]. Through our process of finding information for the decks, we were unable to find 8 of the decks previously examined as their referenced links were no longer accessible and google search yielded no additional information (e.g., Push Your Design Methods Cards by Gary Burns). In addition, there were some decks that were coded that were really about card-based methods that did not actually contain any content. Since our goal is to examine the content embedded in the cards, these cards became out of our scope (this included the Card Sort Method from Nielsen, the Collaborative Analysis of Requirements and Design, or CARD approach [51], and LayeredCARD [41]. Finally, there was a set that were card-based games that were not related to design or creativity specifically, which we also excluded. This resulted in a final of 133 decks from prior work.

In addition, we also searched for additional decks that were potentially overlooked, or published after these prior studies (between 2013 and 2020). For cards introduced in academic papers, we used the keywords “design cards” in Google Scholars. We looked through the 617 results returned. Many of these results were about the use of design cards in a design process/workshop. Of the papers that did present new decks, we included only the ones where either a somewhat complete set was presented in the paper, or if the deck was available online. This is to ensure that we can assess the content of the cards, but also to scope our analyses to decks that were intended to be used by others (as opposed to one-off research projects). To explore decks created by practitioners that were not published in academic literature, we used the same date range of 2013 to 2020 on Google search for “design cards”, and included complete decks that we came across within the first 200 results. These processes resulted in 28 additional decks, making the total of decks in our set 161.

4.2 Workshop Coding with Experienced Practitioners

We held a workshop with experienced design practitioners to generate initial codes for the design cards. This first step helps ensure that we consider practitioners’ perspective in our process and generate categories that may be meaningful and useful to them. Due to the time constraints of the workshop, we selected a subset of the decks to code and discuss (42 decks that were well known and most accessible).

To code the insights embedded in the cards (*what*), two of the co-authors who each had more than 10 years of experience in teaching design and have publications related to design cards [removed for blind review] generated an initial set of categories. These categories were based on their prior experiences with design cards, their categorization of the 42 decks selected, and from using categories identified in previous studies of Design Cards [4, 46, 53].

This resulted in an initial set of: (1) Methods & Tooling; (2) Problem Definition; (3) Human Insights; (4) Domains; and (5) Materials. Two weeks prior to the workshop, we sent the workshop participants information associated with each deck, asking them to individually assess all 42 decks before convening as a group. The provided information included a list with 42 decks and links to any available information we were able to find on the decks, such as published academic papers associated with the decks, official websites of decks, and complete sets or at the very least sample cards of the decks. While we asked participants to categorize the decks using the five categories that we had generated, participants were told that these categories were preliminary and that they could and should adjust them as needed. Participants were also given a comments field to take notes about the cards and categories. This ensured that the participants went through all the decks and made their own assessments ahead of the workshop while providing them with sufficient flexibility to categorize the cards. A few days prior to the workshop, we sorted their categorizations of the decks by using the degree of consensus, and at the workshop, we discussed the design card decks with the highest degree of consensus first to help ease participants into the more contentious discussions.

During the workshop, participants were invited to share their opinions and experiences, explaining why they made the decisions that they made ahead of the workshop. For each deck, we also discussed when each tool may be used. To map the 42 decks to applicable design phases (*when*), we used the Double Diamond (DD) design process [52] derived from Banathy's 1996 "dynamics of divergence and convergence model" [9]. The process model breaks design down into four key stages: (1) Discover; (2) Define; (3) Develop; and (4) Deliver.

4.2.1 Participants. Four expert design practitioners with work experience ranging from 7-28 years in industry participated in the workshop. They each received \$110 USD as compensation in exchange for participating. The design experts brought a range of skills, experiences, and perspectives to the workshop. Expert 1 was a Senior Product/User Experience Designer at Mozilla with 7.5 years of experience designing digital platforms as well as prior experience working in project management. Expert 2 has over 15 years of design experience and was a Program Manager at a non-profit foundation that focuses on providing service design solutions to non-governmental organizations (NGOs). Expert 3 had over 28 years of design experience while currently working as a Strategy Director of the first design consultancy to focus on user experience design and serving as Director of a professional design association. Lastly, Expert 4 was a Director of Research Development in a design unit of the Taiwanese government and lecturer at a top design institution in Taiwan with over nine years of work experience in total. All the experts also had prior experience using card-based design tools in practice. They have used a few of the decks being coded, and have general experience with using card-based tools in their work, but were not aware of most of the decks prior to participating in the workshop.

Two of the co-authors (who generated the initial codes) facilitated the workshop. They were further supported by four design students, who helped with setting up the workshop equipment (i.e.,

posters, computers, recording equipment) as well as documenting discussions in the form of text, photos, and audio recordings.

4.2.2 Initial Codes. For coding *what* insights are contained within the cards, a few of key observations were noted during the workshop discussions. First, a couple of experts reported challenges differentiating between "Domains" and "Materials" as discrete categories. For example, some of the design cards were related to designing for AI, which could be coded as either one: AI as a material or AI as a domain. Through our discussion, we decided to merge the two categories. Second, experts pointed out that some of the design cards could not actually support any of the categories since they did not embed any "knowledge" in them. Instead, the experts thought these cards, which mostly contained visual images, were designed to provide creative inspiration. For example, the New Metaphor Cards [33] simply included pictures with labels intended to incite metaphorical thinking and did not contain any other specific information about the images themselves. Therefore, we added a Creative Inspiration category for these types of cards. Finally, the experts found that some card decks may contain multiple sets of insights, so we noted this as well. After this stage, the categories of what insights they contain were: (1) Methods & Tooling; (2) Problem Definition; (3) Human Insights; (4) Materials & Domains; and (5) Creative Inspiration.

As for *when* the cards may be utilized during design processes modeled on the Double Diamond design framework, the experts pointed out that some decks such as the 18F Methods [1] could be used before design processes begin. For instance, these cards could be used to prepare for design work. Experts also found that card decks such as Bootleg Method Cards [8] are most useful for design education. Thus, we added two more stages to capture this: Pre-Stage, to account for design planning and preparation, and Meta-design to support practitioners in gaining a design mindset or design skills. Workshop participants also discussed challenges with using the DD framework for categorizing the cards. For example, DD places ideation under "Develop," but "develop" is often used more colloquially to describe the building of web applications. Similarly, the "Deliver" stage in DD broadly covers prototyping, building, and releasing. However, the term does not explicitly convey such a wide range of design activities. This led to confusion in our discussions and raises concerns about the use of these four design phases for categorizing design cards.

4.3 Expanded Coding

Using the initial set of codes from the workshops, we conduct additional rounds of coding amongst the authors to incorporate the additional decks that were not analyzed in the workshop. Four of the authors examined each of the decks separately, and met to discuss any changes needed to the codes and updated the codebook. Then, two of the authors completed the coding of all the decks. Any final discrepancies were discussed amongst the authors until a consensus was reached.

4.3.1 Updated Codes. After adding more decks, we observed two more categories emerging for the *what*. The first stemmed from sets of cards intended to support not individual design work per se, but rather design teamwork and camaraderie. This type of team



Figure 1: Reframe Creative Prompt Tool Reprinted with Permission of Philippa Mothersill [39]

building cards were also identified in Roy & Warren [46]. Second, we noted that a considerable number of decks also provided ways of accounting for values in the design process. We decided that this was also a useful categorization for those who may want to interrogate the values that they embed within artifacts. Thus, we added two more categories: Team Building and Values in Practice. The final categories are: (1) Creative Inspiration; (2) Human Insights; (3) Material & Domain; (4) Methods & Tooling; (5) Problem Definition; (6) Team Building; (7) Values in Practice.

After iterating on the *what*, we also assessed the cards based on *when* the embedded insights may be applicable in practice. We found some limitations with the codes generated through the workshops. First, there appeared to be a strong overlap between the Pre-stage and Meta-design cards. More specifically, the Pre-stage cards seemed to be a subset of the Meta-design cards. Thus, we merged these two categories. Second, as we had noted from the workshops, the Double Diamond (DD) process model did not clearly map onto the more commonly described iterative design process terms: Research, Ideation, Prototyping, Implementation, and Evaluation. Given these limitations, we moved away from the DD model, concluding that more accessible and descriptive classifications would better support those who may not subscribe to the UK Design Council way of thinking about design phases. Instead, for our classification, we used: Research, Ideation, Prototyping, Implementation, Evaluation, along with a Meta category.

With the updated codebook, two of the authors coded the rest of the decks. Out of 161 decks, there were slight discrepancies in 48 of the decks coded. However, the interrater reliability for each of the coded dimensions were strong, with an average of Cohen's Kappa at 0.85, ranging from 0.96 (What: Team Building) to 0.74 (When: Prototyping).

5 FINDINGS

Our classification process resulted in: (1) Seven categories of *what* insights are contained in each tool, and (2) Six categories of *when* in design processes those insights may be utilized. We begin by discussing these categories, then we present findings from our exploratory analyses of patterns and trends that emerged.

5.1 Seven Types of Knowledge Contained in Design Cards

Creative Inspiration. This category of card-based design tools aims to creatively inspire and to help card users think outside the box by presenting provocative prompts or visuals to spark ideas. During our coding discussions, we realized that nearly all design card decks can creatively inspire card users by facilitating generative and creative thinking in some shape or form. However, some card-based design tools exclusively support creative inspiration. Therefore, we

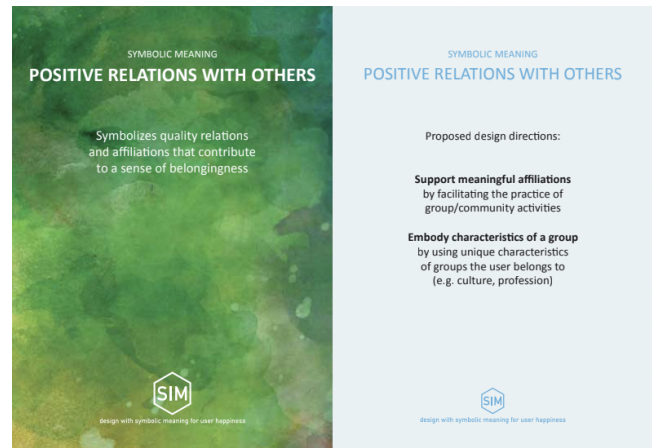


Figure 2: SIM Cards: Design with Symbolic Meaning for User Happiness Reprinted with Permission of Mafalda Casais [18]

reserved this classification for those that only serve this function and do not communicate any other design knowledge (except for Values in Practice in some cases since some creative inspiration decks are provocative in nature and aimed encourage critical reflection). An example of Creative Inspiration card-based design tool is the Reframe Creative Prompt Tool [39] built at the MIT Media Lab to facilitate interactive ideation by provoking new ways of thinking about concepts and projects (Figure 1). Design practitioners can randomly generate card-like prompts and write in their own ideas.

Human Insights. This type of card embeds insights about humans to help card users understand knowledge about people and how design affects them. Cards in this category often contain insights about human behavior or psychology, which practitioners can apply to designing better user experiences. For instance, SIM Cards [18] can help practitioners learn about positive design mechanisms to support the long-lasting happiness of users by designing with symbolic meaning (Figure 2).

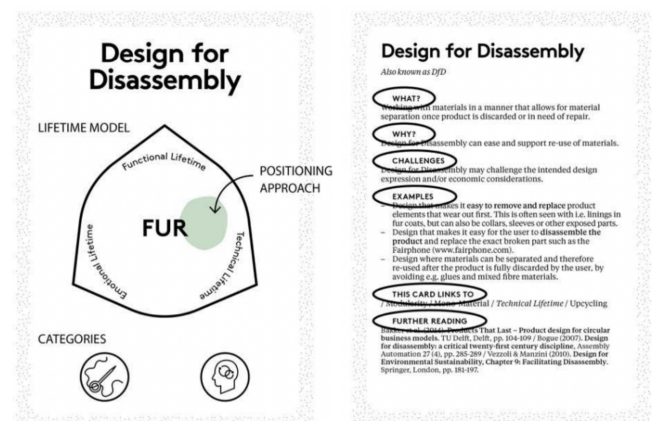


Figure 3: Sustainable Design Cards Reprinted with Permission of Lab for Sustainability and Design, Design School Kolding [45]

Material & Domain. This category facilitates the dissemination of knowledge about specific domains or subdomains of design, where a domain is broadly construed; this could be a domain in terms of the type of technology, material (e.g., AI [2, 3]), modality (e.g., sound [6]), design context (e.g., home life [38]), field of study or industry (e.g., the sharing economy [21]). It could also help provide domain-specific insights related to history and trends as well as challenges, guidelines, technologies, tools, and potential solutions therein. For instance, the Sustainable Design Cards [45] materialize emotional, functional, and technical domain knowledge to support sustainable product design for longevity (Figure 3).

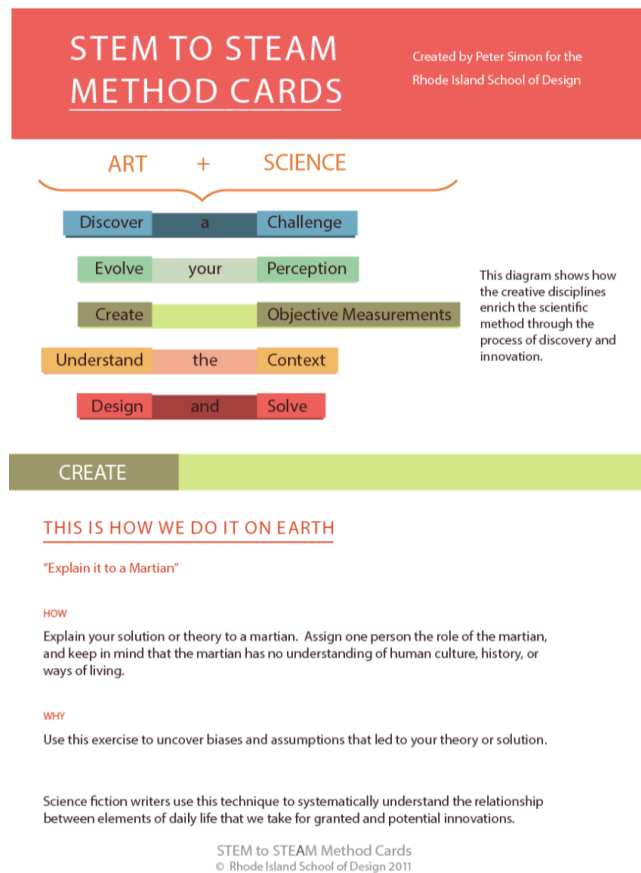
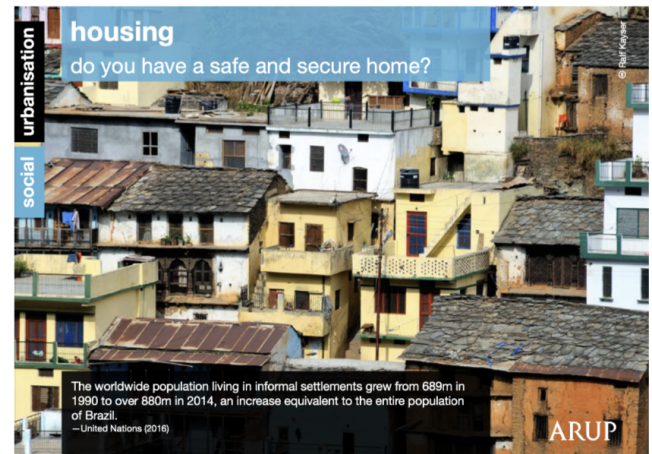


Figure 4: STEM to STEAM Method Cards Reprinted with Permission of Peter Simon and the Rhode Island School of Design [49]

Methods & Tooling. This type of card is primarily intended to help card users understand different design methods and tools to expand their practices. An example of cards in this category is the STEM to STEAM Method Cards [49] (Figure 4). These cards provide methodological approaches to fuse the rationality and logic of scientific methods with the cultural awareness and aesthetic sensibility of the humanities in design processes. Since design exists at the nexus of the arts and sciences, these cards are useful for

exploring balanced approaches that resist the more binary ways of thinking and practicing.



housing

Adequate and affordable housing has been recognised as a fundamental human right since the Universal Declaration of Human Rights in 1948. However, cities in developing and developed nations alike are struggling to provide housing for a rapidly expanding urban population. The threshold for housing affordability is widely defined by a maximum of 30–40% of income spent on housing. Around 330M households worldwide were financially stretched by housing costs in 2014 (Fig 1). The UN estimates that one billion new housing units will be needed by 2025 to meet the demand of growing urban populations.

Rapid urbanisation, especially in countries without strong building regulation, is often accompanied by the development of informal settlements. According to UN estimates, almost 40% of urban expansion across the globe is occurring as informal settlement. In some regions, informal development can house well over half the urban population, reaching nearly 80% in some Latin American cities (Fig 2). Informal settlements present many challenges to residents, including poor quality, overcrowded housing; absent or ad hoc infrastructure and limited access to public services, health care and employment.

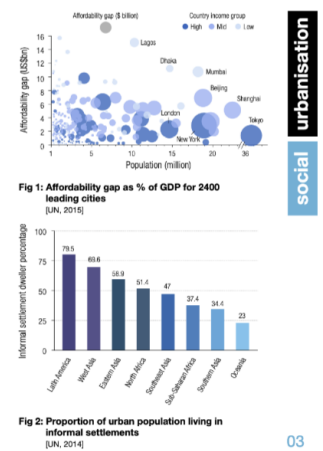


Figure 5: Drivers of Change Cards Reprinted with Permission of Arup [36]

Problem Definition. This type of card is designed to help card users understand and frame problems to define them in the context of design. Cards in this category provide problem-specific information, which practitioners can use to address design problems. For example, the Drivers of Change Cards [36] present detailed information about waste, water, climate change, demographics, energy, and urbanization, which practitioners can use to design remedies for these problem areas (Figure 5). This category appears relatively underrepresented because practitioners often define and address problems by gathering insights about humans, materials, and domains. Since other categories reflect these areas, this category was reserved for cards containing insights about problems beyond human-centered insights and material/domain-specific knowledge. As such, these cards may be especially useful for designers looking to define problems in terms of not only humans or materials, but also the environment and other non-human factors, which other categories may not necessarily capture.

Team Building. Cards classified in this category can support practitioners such as design managers in facilitating teamwork and building teams. The cards provide guidance on collaborating effectively and reflecting on interpersonal relations. For instance, the Group Works Cards [44] can help facilitate discussions and reorient group dynamics (Figure 6). Cards in this category can also be used to help teams reach consensus as well as work better together and thus design better artifacts.



Figure 6: Group Works Cards Reprinted with Permission of the Group Pattern Language Project [44]

Values in Practice. This category offers to help practitioners take values into account throughout the design process. For example, the Envisioning Cards [24] help practitioners account for values throughout the design process (Figure 7). We define this function as supporting values in practice, meaning that the cards are mechanisms for designers to interrogate the values that they are embedding and materializing within the artifacts as well as in their interpersonal relations. Relative to other cards that support more surface-level exploration and ideation, these offer greater depth in the sense that they may facilitate value sensitivity, ethical considerations, and principles such as inclusivity in the design process.

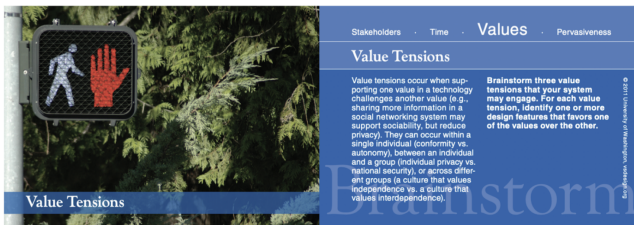


Figure 7: Envisioning Cards Reprinted with Permission of the Value Sensitive Design Lab, University of Washington [24]

5.2 Uses of Design Cards Across Six Stages of Design

Research. This is the stage where practitioners investigate the problem space that which design is intended to address. This can involve

understanding the stakeholders, often psychologically and socio-logically, as well as the challenges that they are facing. Research typically happens first as it can be used to inform design decisions. As an example of cards that support this stage, the Drivers of Change cards [36] provide insights about “key global issues and trends driving change in the built environment” (Figure 5). Practitioners can use the cards to glean key facts and statistics about these areas to understand the problem spaces. Relative to other card decks, ones that are useful for this stage tend to be more fact-based and data-driven.

Ideation. This is the stage where practitioners generate design ideas through creative brainstorming. Cards that offer inspiration or insights about humans and problems are particularly useful at this stage. Thus, most cards fall into this category. In rarer yet no less noteworthy cases, some cards also incorporate values at this stage by prompting ethical considerations. For example, the Behavior Change Design Cards [16] support ideation of designs that facilitate theory-driven behavior change while also providing warnings as to what ideas should be avoided when materializing designs in this domain (Figure 8).

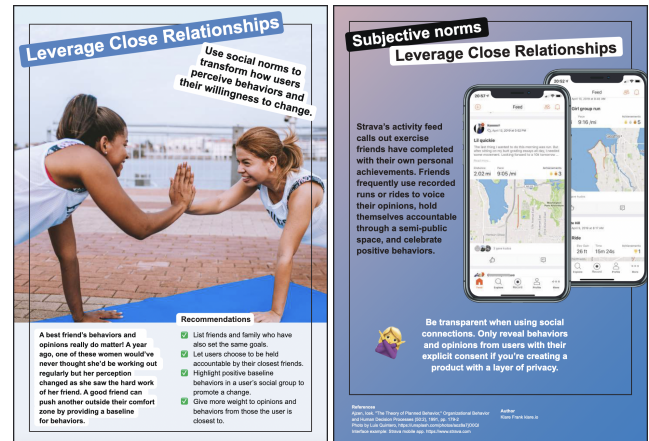


Figure 8: Behavior Change Design Cards Reprinted with Permission of Prosocial Computing Lab, University of Washington [16]

Prototyping. At this stage, practitioners transform their ideas or potential solutions into low or high fidelity designs that test the production viability. This enables practitioners to garner rapid feedback before translating their designs into products. In addition to enabling evaluation, prototyping also serve a generative role to help designers reflect on their design activities and traverse design spaces [31]. While prototyping is a core part of most design processes, it can be difficult, especially with more abstract materials such as artificial intelligence or domains that designers are less familiar with but want to explore. Thus, card-based design tools present opportunities to help designers expand their prototyping mechanisms often in material or domain-specific contexts. For instance, the award-winning iD Cards [20] for the industrial design domain contain a specific subset of cards in the deck to support practitioners by visualizing different ways for them to explore product viability (Figure 9).



Figure 9: iD Cards supporting prototyping. Reprinted with Permission of Mark Evans, School of Design and Creative Arts, Loughborough University [20]

Implementation. This is the stage at which practitioners specify details to translate prototypes into production items, working with manufacturers, developers, and other product specialists. The iD Cards similarly exemplify how cards can support implementation in terms of the Detail Design stage in the context of industrial design [20]. Some of the cards can be used for detailing specifications of production items in terms of materials, dimensions, and assembly to bridge the gap between industrial designers and product manufacturers (Figure 10). Relative to other stages of design, however, implementation has far fewer cards associated with it, which suggests opportunities for future cards to support this dimension in practice.

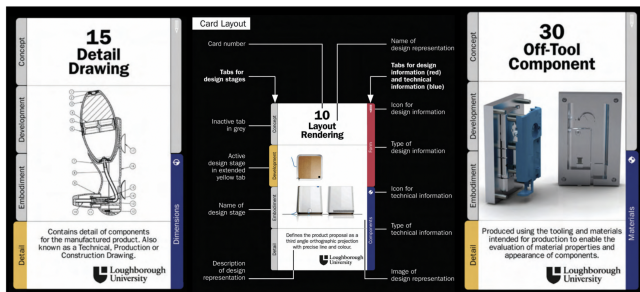


Figure 10: iD Cards supporting implementation. Reprinted with Permission of Mark Evans, School of Design and Creative Arts, Loughborough University [20]

Evaluation. This is the phase where designers assess whether people can and how they use the design solution. Cards supporting this phase can provide heuristics and methods. For instance, the AI Ethics Cards [3] can be used to assess AI design decisions (Figure 11). Card-based design tools that support evaluation can also help practitioners by providing an aggregated set of metrics to

reference and ensure that design solutions align with criteria that were established in an original design or prototype. Much like implementation, evaluation is relatively underrepresented, which also presents opportunities for future cards to aid this design dimension.



Figure 11: AI Ethics Cards by 33A licensed under CC BY-SA 4.0 [3]

Meta-design. This aspect transcends the design process model as it does not map to any one phase or task in practice. According to the definition from Fischer & Scharff [22], “Meta-design characterizes activities, processes, and objectives to create new media and environments that allow users to act as designers and be creative.” Thus, this category captures cards that support designers as creators beyond the bounds of process models. For instance, the Group Works Cards [44] can help design teams reflect on how they co-create and relate, navigating power dynamics as well as labor divisions and politics (Figure 6).

5.3 Patterns and Trends in Design Cards

Here, we present several descriptive analyses of the coded categories, and explore changes in these categories over time.

5.3.1 Distribution and Correlation Across Decks. Overall, we found that the decks analyzed offered a range of design insights and may help practitioners across different stages of design. In terms of design knowledge embedded, the largest category is Materials & Domains (46% of the cards), and the smallest categories are Team Building (9%) and Problem Definition (12%). In terms of design stages of use, the cards tend to have a more uneven distribution, the top two categories of ideation (81%) and research (36%) make up 86% of the cards, while implementation, for example, makes up less than 2% of the cards. This indicates that these design cards primarily support early stages of design, and there are fewer decks supporting prototyping, implementation, and evaluation (Table 1).

While some decks do serve multiple purposes, the majority of decks do seem to have been designed for a specific intended use. 55% of our decks were coded as containing one specific type of

Table 1: Distribution of Design Cards Across Categories

	<i>What</i>							<i>When</i>					
	<i>Creative Inspiration</i>	<i>Human Insights</i>	<i>Materials & Domains</i>	<i>Methods & Tooling</i>	<i>Problem Definition</i>	<i>Team Building</i>	<i>Values in Practice</i>	<i>Research</i>	<i>Ideation</i>	<i>Prototyping</i>	<i>Implementation</i>	<i>Evaluation</i>	<i>Meta</i>
N	32	31	74	33	20	14	60	58	130	22	3	23	47
(%)	(20%)	(19%)	(46%)	(20%)	(12%)	(14%)	(37%)	(36%)	(81%)	(14%)	(2%)	(14%)	(29%)

design knowledge. This is especially true for Creative Inspiration and Method & Tooling cards, where 84% and 79% (respectively) of these cards do not have another category coded. This suggests a few things. First, there is a very distinct cluster of Method & Tooling cards, whose purpose is to help teach designers about a variety of user research or design methods. They are also very easy to identify, as evident in our high agreement in categorization. Second, there is more of a blurring of functionality across the other categories of Human Insights, Problem Definition, and Materials & Domain cards. This is likely because domain-specific insights could also include insights about users, and human insights could also include insights about humans in specific domains. For example, the set of decks related behavior change were coded as both Human Insights and Materials & Domains. They tend to include information about people, as well as people in specific contexts. Problem Definition cards also tend to be contextualized, either by the users or the specific domain. This is because the exploration and framing of problems often requires insights about people and/or domains. This suggests that these categories could potentially be merged into a higher level category if the goal is to generate a taxonomy with distinct categories. However, keeping these separately coded could be more useful for designers who may be seeking different types of information. For example, some Human Insights cards are more general (e.g., Human Drive [5]) and may be used broadly to help understand human needs for designing across several domains.

Similar to the *what*, 61% of the cards also target specific design phases. There are, however, two types of cards that contain insights that can support card users across multiple phases. First, 82% of the Methods & Tooling cards can be used across various design phases. While there are Method & Tooling cards that focus on specific design phases, most of these decks tend to be broader learning tools that contain cards to be used across the design process. Second, there is also an overlap between cards for Research and Design. This is perhaps reflective of the design process where research and design are often integrated in an iterative cycle and hard to differentiate. Cards that support co-design [e.g., 25], for example, support both learning about stakeholders, as well as brainstorming potential solutions.

5.3.2 Changes in Card Types Over Time. To explore how the development of design cards has changed over time, we explored the different types of cards by the year it was released. For our analyses, we explored both five-year and ten-year windows. The results

were similar. Here, we will present results from the more granular analysis (five clusters: pre-2000, 2001-2005, 2006-2010, 2011-2015, and 2016-2020).

The first observation is that there is a general growth in design cards. The number of decks grew from 9 (from pre-2000) to 13 (2001-2005), 25 (2006-2010), 61 (2011-2015), and 53 (2016-2020); 70% of the cards analyzed were developed within the past decade. One factor to consider here is the survivorship bias where older decks may be more likely to be missing from our analyses because they were no longer accessible. However, this alone may not account for the more than tripling of new card across the past three decades (Figure 12). While there seems to be a slight drop in new card decks when comparing between in the most recent 5-year window (2016-2020) to the five years prior (2011-2015), this is mostly due to 2012 being an outlier year with 18 decks (yearly breakdown of the cards can be examined in the Appendix).

Focusing our analyses of the knowledge contained in the cards, we found that while there was just one deck of Materials & Domains cards prior to 2000, they have since become the most numerous type of card (about 58% of the cards generated between 2016 and 2020), overtaking Creative Inspiration and Methods & Tooling cards that combined to make up of nearly half of the cards up before 2010 (32% and 21% respectively). This is likely reflective of the changing nature of design. The early designer cards were more artistic and were primarily to support creative inspirations for designers. With the growth in design as a field of research and practice, Methods & Tooling become embedded in these cards to support the adoption of various design processes. Then as the field matures, and as the application of design becomes more complex, more insights about domains is needed. For example, with the rise of AI, a number of AI Domain cards have been developed since 2019 as exemplified by card decks such as the Microsoft AI Design Guidelines [7], AI Design Sprint cards [2] and AI Ethics Cards [3]. This time-frame is related to the emergence of Human-Centered AI. Likely for similarly reasons, we also see a rise in Value in Practice cards (50% of the cards in the 2016-2020 window). As more people gain training in the technical skills of design, there is a growing realization and need to be more reflexive and critical. A growing number of decks thus include insights and support for discussions about values and ethics.

In terms of trends in when these tools apply, the ideation cards were the first type of deck to be developed in 1952 [19] and have remained the most popular type well into the 2000s. This is likely

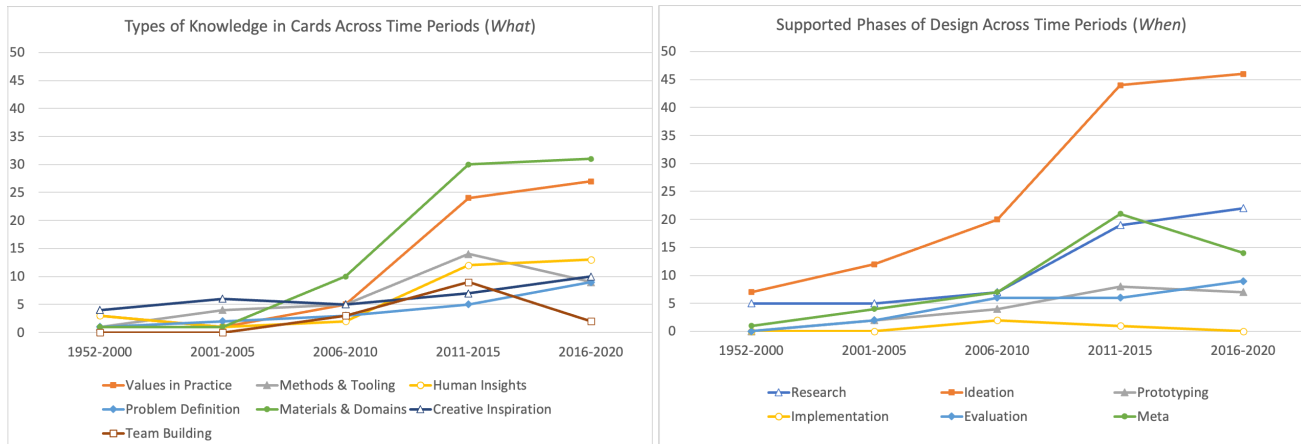


Figure 12: Changes in Card Types Over Time. Left: Supported phases of design over time periods. Right: Design cards usage over time periods.

Table 2: Categories of Design Card Functions and Content

Wölfel and Merritt’s Classification (Intended Purpose and Scope)	Roy & Warren’s Classification (Purpose or Function and Content)	Our Classification (Knowledge Embedded in Cards)
General/Repository Tools Participatory Design Tools Context specific/agenda-driven examples	Human-centered design Systematic design methods and procedures Domain specific design Futures thinking Creative thinking and problem solving Team building and collaborative working	Methods & Tooling Material & Domain Creative Inspiration Team Building Human Insights Problem Definition Values in Practice

due in part to the perception that the material-based form and card game-like nature of the tools enables the use of these tools for socializing and sparking new ideas. As discussed prior, research is the second largest category (and remains so over time), although there seems to be a growing set of cards that support the meta-design processes.

6 DISCUSSION

In this work, we surveyed 107 design practitioners about their use of design cards, and we analyzed 161 sets of design cards developed from 1952 to 2020. We discuss some of the key observations and insights that emerged from our work.

6.1 A Taxonomy Classifying Design Cards

Through our iterative coding process with experienced practitioners and researchers, we classified design cards based on what insights are embedded within them and when the embedded insights may support designers in practice. This effort answers previous calls from the community to articulate what design knowledge is embedded in these card-based artifacts and builds on recent efforts at classifying design cards [4, 46, 53]. The closest prior classification to our coding is the classification of card functions and content from Roy & Warren [46]. At a high level, there seems to be a number of similarities, such as clusters related to creative inspiration, team

building, methods, and domain. However, there are also several noticeable differences (Table 2).

Of note, methods are coded differently in our work compared to that of Roy & Warren. While Roy and Warren designated two separate methods categories (“Human-centered design” and “Systematic design methods and procedures”), we merged them together as a Methods & Tooling category. This was because it was not clear to us that there was a distinct separation between the two. For example, Roy & Warren coded the SUTD-MIT Design Methods Cards [14] as “Systematic design methods and procedures” and IDEO Design Cards [28] as “Human-centered design,” but they seem to serve the same function to designers, which is to provide methodological guidance. Additionally, as more methods from different fields are being incorporated into the design process—and the field increasingly challenges and reckons with the limitations of “human-centered design” (e.g., in supporting more-than-human concerns)—it seemed necessary to update and broaden this category to be more inclusive. Another important thing to note is that because of our focus on coding the card content, we coded decks as “Methods” only if the cards provided explicit insights on the methods or how to perform the methods related to design. Otherwise, all the decks would be coded as methods as they are all “tools” that can help designers with some design tasks.

Three additional categories emerged from our process. Two of these categories are Human Insights (providing insights about people) and Problem Definition (understanding problems). These cards

most came from the previous category of "Domain specific design." As noted in our analyses above, there is some overlap across Human Insights and Problem Definition as well as Material & Domain. However, we argue that there is utility in keeping these categories distinct, as they may help designers identify resources accordingly.

Through our process, we also identified a third category of cards: Values in Practice. These cards offer insights on reflexivity and value sensibility. This emerged category is worth noting as while many decks are coded to be in this category, these cards all have another *what* category coded. This seems to suggest that this coded category might be capturing a separate dimension than the *what* (the "types of knowledge"). One likely interpretation is that these cards differ in that they offer a different mode of thinking (reflective) beyond the explicitly articulated content in the cards. The observed growth of these cards in recent years may also coincide with the increasing need and recognition that human centered design requires not just knowledge about design/domain/people, but also support for reflection in practice [48].

Future thinking is a category from the prior classification that did not emerge in our coding. We did notice a number of decks containing insights about designing for the future, but it was difficult to justify this as a separate category compared to other domains; many of which are about designing for what is possible (e.g., cards that contain insights about AI). After all, design in and of itself, by definition, implies a future-looking orientation associated with planning. Through our process, these cards are either coded as Materials & Domain (if they relate to specific domains), or Creative Inspiration and Values in Practice (if the cards are evocative and reflective).

The other dimension that we coded for is when in the design process they may be applied. We began with using the Double Diamond process, but we found that our practitioner participants had challenges mapping the cards usage onto the Discover, Define, Develop and Deliver phases. Instead, we ended up using the commonly referred to phases of design (e.g., Research, ideation). Contrasting our coding to Wölfel and Merritt's, one key difference is that our coding allowed for each deck to have multiple classifications. Thus decks that could be used anytime would have been coded to include all of the phases. Many of the Methods decks, for example, provided methodological support across design phases. We believe that this coding can better help showcase the uses of the cards to practitioners.

Inspired by the "anywhere" in Wölfel and Merritt's classification, we had initially sought to code for more nuanced contexts in which the cards could be used. However, we quickly determined this to be really hard to do. There is limited information on constraints regarding card usage. At best, we were able to identify a handful of decks that specify the number of people required for use (e.g., the Social Mania Game requires 4-10 players [37]). However, other than that, the cards can generally be flexibly used (e.g., alone or with others; during a design team meeting or workshops with stakeholders).

One final point to note about the taxonomy is that qualitative coding is inherently subjective. Our interrater reliability is very high, but there were still some differences in opinion even amongst the authors. It is possible that some of the decks could be used in a more flexible way than how we have coded. For example, one

could argue that some of the decks with inspirational images could be used to solicit users' emotions and help us gain human insights. But we chose not to code that way. When in doubt, we focused our coding on what insights are actually embedded in the cards or are explicitly stated through the descriptions of the cards and when these embedded insights may be used in the design process.

6.2 Barriers Limiting the Use of Design Cards in Practice

Despite the breadth of knowledge that is embedded in existing design cards, our survey results suggest that these design tools are not actively used in design practice. In our sample of 103 design practitioners from the Taiwanese design community, only 18% of them have used these card-based tools in their work. Though this survey presents a regional design community's use of these tools, the results do offer the first (to the best of our knowledge) empirical data on the limited design cards usage in practice. And while the exact percentages of card usage will vary from region to region, the general finding that practitioners do not use these card-based tools in practice does corroborate the authors' observations and experiences beyond just the Taiwan region.

Our research offers some insights on why design cards may not be used in practice. The main reported barrier to usage from our survey respondents is associated with the lack of perceived value – respondents reported that they did not think design cards match their work requirements or present utility. One interpretation is that design cards do not address designers' needs. Our analyses of cards did identify some areas where support is lacking (e.g., implementation), but in general, we found rich set of cards that can support a variety of designerly needs across domains (e.g., AI, inclusive design, behavior change design, value-sensitive design, etc). Thus, we also argue that part of the problem with the low perceived value may stem from an awareness and perception problem. Many of our respondents have not heard of design cards before (40% of respondents), despite being active in seeking design knowledge. Those who have heard of design cards could also only recall a few decks. This suggests a lack of awareness of design cards that are now available, and much less the wealth of knowledge actually embedded in these cards (about methods, about people, about domains, etc).

However, value is but one side of the adoption problem. Our survey also suggests that costs associated with obtaining the cards, and with using the cards, are additional barriers. In commodifying design, many of the design card decks instate monetary barriers that make the knowledge embedded within the materials inaccessible. Other decks are also only discussed in academic papers, which may be harder to find and less understandable to non-academics [15]. Admittedly, it was even difficult for us, experienced designers and researchers, to collect all the decks used in our analyses. The decks also come with a variety of forms of instructions and guides and are designed with a various level of structure and clarity [4]. This is further exacerbated by the lack of organizational norm and support to use these cards. These are all important considerations for future HCI researchers working on developing new design cards to communicate domain-specific design insights.

In general, our finding that design cards have limited use in practice also highlights the need for additional research. In addition to establishing similar patterns of (non)use beyond the Taiwanese design community, we also need to deepen our understanding of perceived value and use of cards that was not explored in our survey. For example, it would be useful to contrast design cards usage from other types of design tools [23, 43] and explore how these resources may complement or why some are use instead in the design process.

6.3 Opportunities to Enhance the Design and Use of Design Cards

Our findings suggest three areas for future research and design to enhance the use of design cards. First, we need to explore ways to better communicate the value of design cards and lower barriers for using these cards. One possible way to overcome this lack of perceived value and awareness is to construct a repository of the card-based design tools, aggregating decks with our taxonomy as the basis. Practitioners could visit the repository and conduct a personalized search to identify ones that align with *what* they want *when* they need it. As more designers find these design cards aggregated online, they could share them with coworkers and help champion the adoption and merit of these tools in practice. This centralized repository could also grow as new cards are introduced to help expose designers to new resources and raise awareness for updates to existing decks. This type of repository would also be extremely useful for educational purposes; useful both as resources in classes and to support self-directed learning.

In addition to awareness, we also need to better support the cards' usability and applicability. Since designers expressed confusion about usage and feel a lack of structural support in using these tools, each deck should provide clear-cut guidelines, concrete examples, well-defined keywords, and visual imagery to communicate how they apply to design work. Explicit articulation of what function the cards serve and when they are usable in design processes can enable more practitioners to actually receive value from the materials and advocate for their use. Some of these recommendations have also been suggested by prior work [4]. Further, as suggested by Culén and van der Velden [17], there may also be opportunities to increase applicability by supporting customization of design cards that enables designers to add or modify card content based on their specific needs. But in addition to making the cards themselves more usable, our findings also highlight the need for structural support and integration. Research on how these tools may be adopted in organizational contexts is needed. How might these tools be implemented in organizational workflows? What additional types of resources or support is needed? To address these questions, we see opportunities for decks to more clearly instruct and draw linkages between how the knowledge that is embedded within the cards can actually support design practices.

Finally, our research also uncovered a lack in the variety of cards available. Most of the design cards in existence support early stages of design. However, what is lacking are more resources to guide later design stages: prototyping, implementation, and evaluation. Some cards that we have identified that can support these stages do offer this in compelling ways and can serve as examples for future card makers. One consideration is that these later design

stages may require different types of domain experts, e.g., engineers for prototyping or implementation and marketing experts for implementation. These experts may need to be included in the card creation process. Nonetheless, there is a rich opportunity to incorporate more diverse knowledge in these card-based design cards to help educate and support designers thinking beyond just research and ideation.

7 LIMITATIONS

One limitation with our work is that our survey was a regional survey conducted in Taiwan. There are likely differences in design tool usages across regions, countries, cultures etc that need to be considered when trying to generalize our findings to other regions. However, Taiwan does have an active design community with English proficient designers (English is compulsory to Taiwanese students' curriculum) working in large international companies and design studios. As the first empirical study of design cards in practice, our results do provide useful insights that serve as valuable basis for future work exploring other regions.

Another limitation with our work is that we may have overlooked additional design card decks that have been developed. This includes sets that were analyzed in prior work that we could not find or have access to, as well as decks that were not found in prior work that we also missed in our searches. While this may affect the number of decks represented in each category, we do believe that our taxonomy is robust and provides an extensive overview of knowledge that may be embedded in design cards. We should also note that our coding is primarily based on information about the cards that we could gather, this includes the cards themselves, available descriptions of the cards, and any associated publications. We have not, however, had the chance to use all these cards given time and resource constraints. Thus, despite high interrater reliability, it is possible that the codes for the decks may vary slightly with more information about, or experience with using the card decks.

8 CONCLUSIONS

New sets of design cards are continually being developed by HCI scholars as well as design and technology companies. This has resulted in a need to better understand the landscape of these growing tools and their uses. We found that despite the wide variety of insights embedded in these cards, and the number of new domain specific cards designed that can support recent trends in design, designers may not be aware of or are unable to discern among offerings. We present a taxonomy of classification that may help practitioners discover relevant design cards given their needs, and offer recommendations and highlight opportunities for developing more useful card-based tools and supporting design cards adoption.

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A APPENDIX: DESIGN CARD DECKS AND CODING

METADATA		WHAT							WHEN					
Name of Design Card Set	Year made	Values in Practice	Methods & Tooling	Human Insights	Problem Definition	Materials & Domains	Creative Inspiration	Team Building	Research	Ideation	Prototyping	Implementation	Evaluation	Meta
1	The House of Cards	1952					•			•				
2	Meta Cards	1972		•					•	•				•
3	Oblique Strategies	1975					•			•				
4	Creative Whack Pack	1989					•			•				
5	Thinkpak. A brain storming card deck	1994					•			•				
6	PictureCARD	1995	•		•				•					
7	CUTA: A simple, practical, and low-cost approach to task analysis	1996			•	•			•					
8	The User Game	2000	•		•				•	•				
9	The Landscape Game	2000	•			•			•	•				
10	Interactive Thread cards	2002		•					•	•				•
11	Envisioning Cards	2002	•		•	•			•	•				
12	IDEO Method Cards	2003		•					•	•	•		•	•
13	Meta Memes	2003					•			•				
14	Innovative Whack Pack	2003					•			•				
15	The KnowBrainer Thinker Tool 3.0	2004		•						•				•
16	TRIZ Solution Cards	2004					•			•				
17	Design Thinking Method Cards	2005		•					•	•	•		•	•
18	Idea Generator	2005					•			•				
19	Free the Genie Cards	2005					•			•				
20	Inner Vision deck	2005					•			•				
21	The Nordvest game	2005			•				•					
22	Domain Cards; Technology Cards; Inspiration Cards Workshop	2005				•				•				
23	Drivers of Change	2006	•		•	•			•	•				
24	SILK Method Deck	2007		•					•	•	•		•	•
25	Powerful Facilitation Cards	2007						•						•
26	Mobility VIP (Vision Integration Process) cards	2007	•		•	•				•				
27	EyeWire Creativity Cards	2008					•			•				
28	VNA (Verbs Nouns, Adjectives) Cards	2008					•			•				
29	The workplace game	2008	•					•						•
30	Eco-Design Cards	2008	•			•				•				
31	Service Design Tools	2009		•					•	•	•	•	•	•
32	Thinkcube	2009					•							•
33	Ideation Deck	2009					•			•				
34	Design Heuristics	2009					•			•				
35	Social Mania Game	2009				•				•				
36	Experience Design 1 Cards	2009				•				•				
37	Project Planning Game	2009						•						•
38	PLEX Cards	2009				•				•				
39	UX Basis. UX in a Box cards	2010		•					•	•			•	
40	iD Cards	2010		•		•				•	•	•		
41	Bootcamp Bootleg Method Cards (2010)	2010		•					•	•	•		•	•
42	Mental Notes	2010			•					•				
43	Game Seeds	2010				•				•				
44	SCVNGR (SCaVeNGeR) Secret Game Dynamics	2010				•				•				
45	Design with Intent Cards	2010			•					•				
46	AT-ONE Touchpoint Cards	2010			•				•				•	
47	Tangible Interaction Framework Cards	2010	•			•			•	•			•	
48	STEM to STEAM Method Cards	2011	•	•		•				•				
49	Dynamic User Experience Context Cards	2011				•				•				

METADATA			WHAT						WHEN					
Name of Design Card Set	Year made	Values in Practice	Methods & Tooling	Human Insights	Problem Definition	Materials & Domains	Creative Inspiration	Team Building	Research	Ideation	Prototyping	Implementation	Evaluation	Meta
50	inSights Cards	2011			•	•				•				
51	Design Play Cards: Designing for sustainability	2011	•			•				•				
52	Values at Play: Grow a game	2011	•			•				•				
53	TechCards	2011	•					•						•
54	i/o cards	2011				•				•	•			
55	Sound Design Deck	2011												
56	DSD Cards	2011		•		•			•	•			•	
57	Method Kit (Web Development)	2012		•		•				•	•		•	
58	Innovating for People: Human-Centered Design Planning Cards	2012		•					•	•	•		•	•
59	SUTD-MIT Design Methods Cards	2012		•					•	•	•	•	•	•
60	Design Fiction Product Design Kit	2012					•			•				
61	Questionable Concepts	2012	•				•			•				
62	PACE Card Deck	2012	•				•			•				
63	Adding Play Toolkit	2012				•				•				
64	Design Axioms	2012				•								•
65	Check-in Deck	2012						•						•
66	BIAS A Game for Product Designers and Strategists	2012			•									•
67	Method Kit (Workshop Planning)	2012				•								•
68	Surviving Design Projects	2012	•					•						•
69	Group Works	2012	•					•						•
70	L+D Leadership + Design Collaboration Cards	2012	•					•						•
71	Foresight Cards	2012	•			•			•	•				
72	Human Drives	2012	•		•				•	•				
73	DOC Method Cards: Designing Out Crime	2012	•		•	•			•	•				
74	Design for Well-Being in China	2012	•		•	•			•	•				
75	75 Tools for Creative Thinking	2013		•						•				
76	Zig Zag Creativity Cards	2013		•						•				
77	The A3 Thinkers Action Deck	2013		•	•				•					•
78	Intüiti Creative cards	2013					•			•				
79	Disruptus	2013					•							•
80	Teamwork Cards	2013	•					•						•
81	WeI Connect Cards	2013	•					•						•
82	Visual Explorer Cards	2013	•					•						•
83	Behavior change strategy cards	2013			•	•				•				
84	Design thinking Prototyping Cards	2013				•				•	•			
85	Totem Cards. A tool for visualising the invisible	2013	•			•		•	•	•				•
86	64 Concepts of Pattern Theory card deck	2013	•		•	•			•	•				
87	The Security Cards. A security threat brainstorming kit (Creative Commons 3.0)	2013	•		•	•			•	•				
88	Security and Privacy Threat Discovery Cards	2013	•			•			•	•				
89	Tango Cards	2013				•			•	•			•	
90	UNSTUCK Conjure Your Creativity tip cards	2014		•						•				
91	circles of visual interpretation	2014		•		•			•					
92	UX Techniques Trading Cards	2014		•					•	•			•	•
93	The Design Deck: A playing-card guide to graphic design	2014				•								•
94	Website Deck	2014				•				•				
95	The Art of Game Design: A Deck of Lenses	2014				•				•				
96	Exertion Cards	2014				•				•				
97	Design to Connect	2014				•				•				

METADATA			WHAT						WHEN					
Name of Design Card Set	Year made	Values in Practice	Methods & Tooling	Human Insights	Problem Definition	Materials & Domains	Creative Inspiration	Team Building	Research	Ideation	Prototyping	Implementation	Evaluation	Meta
98	Liberating Voices	2014	•		•	•				•				•
99	Design Thinking Kit	2015		•					•	•				
100	DRIP SIP: Design Thinking Playing Card Deck	2015		•					•	•	•			
101	IDEActivity Card Deck	2015		•					•	•	•			•
102	Co-Creation cards	2015		•					•	•	•			•
103	The Thing from the Future	2015	•				•			•				
104	Interaction Tarot	2015	•				•			•				
105	Mixed Reality Game Cards	2015				•				•				
106	Technique and Technology	2015			•	•				•				
107	Persuasive Patterns Card Deck	2015			•	•				•				
108	Personas, Superpowers and Ethics	2015	•		•	•				•				
109	Khandu	2016		•										•
110	UTS Method Cards	2016		•					•	•				•
111	Inclusive design Toolkit	2016	•	•		•			•	•	•		•	
112	Trigger: Innovation Deck	2016					•			•				
113	Paradox Cards	2016					•			•				
114	Open Mind's Creativity Cards	2016					•							•
115	TMAP (Technology mediated audience participation in live music) Cards	2016				•				•				
116	Unico	2016	•					•						•
117	SIM Cards	2016	•		•	•				•				
118	Barriers to change	2016			•	•			•	•				
119	Loyalty Theory Flash Cards	2016	•		•	•			•	•				
120	ODS (Ontario Design Services) Method Cards	2017		•					•	•				•
121	IBM Design Thinking Method Cards	2017		•					•	•			•	•
122	design(human)design	2017					•			•				
123	Designercise Ideation Toolkit	2017					•			•				
124	Brainstorm Cards	2017	•				•			•				
125	Sustainable Design Cards	2017	•			•				•				
126	Context Cards	2017	•			•				•				
127	Home Life Insight Cards	2017	•			•				•				
128	Generominos: Ideation Cards for Interactive Generativity	2017				•				•	•			
129	Design-Type Design Cards	2017				•					•			•
130	Museum Futures Insights Cards	2017	•			•			•	•				
131	Inclusive Design Cards	2017	•		•	•			•	•	•			
132	18F Methods	2018		•					•	•	•		•	•
133	Design Thinking Bootleg (2018)	2018		•					•	•	•		•	•
134	Method Cards	2018		•					•	•	•		•	•
135	Challenges Cards	2018					•							•
136	Spark: The Soulsight Deck of Bright Ideas	2018					•			•				
137	New Metaphors	2018					•			•				
138	TRIZ Brainstorming Cards	2018					•			•				
139	Metaphor Cards	2018	•		•					•				
140	Travel Experience Toolkit	2018			•	•				•				
141	Behavior change design cards	2018	•		•	•				•				
142	IOTT Design Cards	2018	•			•			•	•				
143	Tiles IoT Toolkit	2018	•			•			•	•				
144	Mindful Design Cards	2018	•			•			•	•			•	•
145	MIX Cards	2019				•				•				
146	AI Design Sprint Cards	2019				•				•				

METADATA			WHAT						WHEN					
Name of Design Card Set	Year made	Values in Practice	Methods & Tooling	Human Insights	Problem Definition	Materials & Domains	Creative Inspiration	Team Building	Research	Ideation	Prototyping	Implementation	Evaluation	Meta
147	Microsoft AI Design Guidelines	2019				•				•				
148	Liberating Structures Design Cards	2019	•					•						•
149	Community Heuristics for Crowdsourcing	2019				•				•			•	
150	Sharing Economy Design Cards	2019	•			•			•	•				
151	Behavior Change Design Cards	2019	•		•	•			•	•				
152	IDEO AI and Ethics Cards	2019	•			•			•	•			•	•
153	Social Accessibility Method Cards	2020	•	•	•	•			•	•				
154	The Nudge Deck	2020			•	•				•				
155	Food Design Cards	2020	•			•				•				
156	Repurposing Design Cards	2020	•			•				•				
157	Scenario Co-Creation Cards	2020	•		•	•			•					
158	Material Pathways	2020	•			•				•				
159	Autonomous Driving Futures Cards	2020	•		•	•			•	•				
160	Wellbeing Design Cards	2020	•		•	•			•	•				
161	AI Ethics Cards	2020	•			•			•	•			•	