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Card-based design tools: a review and analysis of 155 card decks for designers and designing

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Abstract

Many card-based design tools have been produced, initially to aid creativity and user participation in design, with an upsurge post-2000 when numerous card decks were developed. Reviewers have classified the tools using samples ranging from five to thirty-eight. Our comprehensive inventory and analysis of 155 card-based tools offers a more robust classification, with three-quarters aiming to facilitate creative thinking, human-centred design, or domain-specific methods. The few scientific trials of these tools indicate they enable designers to generate more innovative concepts, and feedback indicates that cards can aid the design process and provide information, methods, or good practice in handy form. However, cards are usually tested and applied by their developers, so more independent trials are needed to establish their effectiveness.

Keywords: *card decks; design tools; design methods; creative design; user-centred design*

Highlights

- Brief history of card decks as design tools
- Comprehensive survey and analysis of 155 card-based design tools
- Classification of the tools into six categories, e.g. human-centred design and creative thinking
- Analysis of how the card-based tools are supposed to work
- Evaluations of the tools based on examples of testing or application

Sets or decks of cards – similar to playing cards – are a long-established tool to aid designing. A literature and internet search shows that there are numerous card decks that may be used as tools for design. In this article we provide a brief history of card-based design tools and examine previous attempts to classify them. We present a new classification based on what is probably the most comprehensive survey and analysis of 155 these tools (listed in Appendix A). We also discuss how card-based design tools are supposed to work, what users think about them, and whether they are effective as aids to designing.

1 A brief history of card-based design tools

One of the earliest examples of card-based design tools is *The House of Cards* created in 1952 by the acclaimed American designers, Charles and Ray Eames. Each of the 54 cards shows a different object. The Eames' refer to these objects as '*the good stuff*', selected to celebrate '*familiar and nostalgic objects from the animal, vegetable, and mineral kingdoms.*' (Yunghans, 2007). Slots on each card enable them to be interlocked (Figure 1) and the cards are often bought as a classic design or plaything. But their intention was to provide images of the Eames' favourite objects to help inspire designers. As Pitiot (2011: slide 31) says, '*The House of Cards was designed to stimulate innovative thinking... working with the cards was intended to improve creativity in a playful way*'.

Other card decks to aid creative thinking and problem solving began to appear in the 1970s, alongside the movement to develop systematic design methods. An example is the *Meta Cards*, published in 1972 for students of an Open University design course. The 20 cards are based on the various chapters in the seminal textbook *Design Methods* by J. Christopher Jones (1970). The *Meta Cards* offer methods for identifying problems, widening the search space, overcoming mental blocks, and helping in design situations where new insights are required. For example, one of the *Meta Cards* suggests starting a design project by '*Collecting relevant information*', but warns '*don't collect more information that you can absorb in the time... which is very little unless it falls into a pattern*'. Another card advises selecting concepts by setting measurable '*Criteria*' that '*enable everyone to agree on whether the design succeeds or fails...they must be measurable.*' (Figure 2). On these cards' reverse is further information, about collecting information and setting measurable criteria.

Figure 1: Charles and Ray Eames' House of Cards (1952) slotted into a structure.

Figure 2: Three of the Meta Cards aimed at different stages of the design process (Crickmay & Jones, 1972)

One of the best-known decks is *Oblique Strategies*, produced in 1975 by Brian Eno and Peter Schmidt, now in a fifth edition and available as an iPhone app. The cards, each of which is a suggested course of action or thinking to assist in creative situations, were aimed at helping artists – especially musicians – to overcome creative blocks, but have been used in other fields, such as graphic design (Nassisi, undated). One of the card's creators, the musician Brian Eno, says,

‘The cards evolved from me being in a number of working situations when the panic of the situation... tended to make me quickly forget that there were other ways of working and that there were tangential ways of attacking problems that were...more interesting than the direct head-on approach.’ (Eno, 1980)

In section 4 we discuss how *Oblique Strategies* and other card-based tools are supposed to work.

Following these early examples, we found two card decks produced in the 1980s and 1990s, which also aimed to stimulate creativity. They are the *Creative Whack Pack*, a deck of 64 cards offering creative thinking strategies produced by Roger von Oech in 1989, which has sold over a million copies, and *Thinkpak: A brainstorming card deck* by Michael Michalko published in 1994, based on Alex Osborne’s SCAMPER idea trigger words (‘Substitute’, ‘Adapt’, etc.). Michalko (2006) contends that Ray Kroc – the founder of McDonald’s – could have applied *Thinkpak*’s principles to create his fast food business. For example, Kroc ‘adapted’ the fast food concept, originally conceived by the McDonalds brothers for their hamburger restaurants. Kroc then expanded the McDonald’s restaurant chain involving methods of ‘substitution’, ‘combination’, etc. Michalko does not claim that Kroc used *Thinkpak*, but demonstrates how its methods could be used to generate successful ideas.

The 1990s also saw the emergence of card-based tools for user participation in design. The first, *Layout kit* and *Organisation kit*, aimed to enable employee participation in the design of workplaces (Ehn & Sjögren, 1991). However, most of these early tools were developed to facilitate user participation in IT systems design. In 1992 *CARD* (Collaborative Analysis of Requirements and Design) was developed at Bell Labs to enable designers and users to redesign task flows in software systems to make them easier and more efficient to use and has been employed by companies such as Microsoft (Tudor et al., 1993). A development of *CARD*, *PictureCARD*, was a visual means of collectively building an understanding of how individuals from other cultures undertake their work and any improvements they would like. *PictureCARD* was developed at Apple to help design a computerised information system for Indian rural health workers (Tschudy et al., 1996).

Other developments of *CARD* were *CUTA* (Collaborative Users' Task Analysis), a Canadian card-based tool for user interface design (Lafrenière, 1996), and *LayeredCARD*, developed at Lotus Corporation, used to design a system to enable its software designers to collaborate more effectively (Muller, 2001). Card sorting is another tool for user participation developed in the 1990s, in this case for identifying users' mental models of a digital system's information structure. In this technique – still widely used – users sort elements on cards, such as web page titles, into groups they find most comprehensible for navigation (Nielsen, 1995).

After 2000 there was a huge increase in the number and variety of card decks produced. By reviewing the literature and searching the internet we found 155 design tools produced as physical card decks, many of which were available to buy (see Appendix A. Supplementary data for our inventory of decks). There were also additional decks produced by students or individual designers for their own use and decks only created in electronic form. We excluded these from our inventory.

Of the 155 there were many tools, such as *SPARK*, aimed at stimulating creativity in marketing, management, etc. as well as design. There were also many new decks for user experience (UX) and digital design. These aimed to help create user-friendly, innovative and attractive websites, apps, interactive devices, etc. One example is nForm's *UX Cards*, which provide a menu of methods to help design usable and attractive digital products and services.

Related to the UX decks were many card-based tools for human-centred (or user-centred) design more generally. The best-known example is the *IDEO Method Cards*. These comprise 51 cards of human-centred design methods, with application examples, which provide ways of empathising with users in design projects. The card deck was originally compiled for IDEO's own teams and to encourage other designers to try methods for making products, services and systems useful, useable and delightful to people. Another well-known deck is the *SILK Method Deck* developed by a team at Kent County Council (UK), which summarises methods for designing human-centred services.

Other card-based tools were developed to help designers in specific domains, such as designing computer games (e.g. Deng et al., 2014), and for specialised topics such as designing for children (Bekker & Antle, 2011). Additional fields for card-based tools were as aids to collaborative team work and for futures thinking (Friedman & Hendry, 2012). In addition, card decks were produced for areas related to design, such as marketing and learning design, that we did not include in our inventory.

2 Strengths and weaknesses of card decks as a design tool

A few developers and reviewers have discussed the strengths, and some weaknesses, of using physical card decks as aids to design.

Carneiro et al. (2012), developers of *i/o Cards* to help design interactive digital artefacts, discuss the strengths of card decks as a design tool:

‘External representations...are important...during a design development...such as sketches, prototypes, models, images and movies. [...] One approach to facilitate externalization and communication during the design process is to organize blocks of contents into tangible paper cards. [...] simply shuffling through the cards and posing the questions creates an opportunity for designers to remember to address more issues than might be in the initial project brief. When used in the context of a design process, cards are not prescriptive; rather they act as a support for inspiration, organization and communication of ideas’ (p 214).

Rothstein (2012) expands on the value of cards as tools for thinking:

‘A card deck is a way of data-basing relatively small quantities information in a printed format, such that it can be handled and sorted in multi-dimensional physical ways and considered by human minds accordingly. [...] by breaking text into smaller chunks by printing it on physical cards, we can more easily violate the categories of information.... This allows our brains' creativity to come in and repair the categories in an ad hoc manner, or manipulate them according to predetermined rules.’

Möller (2014), developer of the *MethodKit*® range of 33 card decks, argues that a key strength of cards for design workshops is that they provide summarised, semi-structured information bridging between unstructured tools without content, like *Post-it* notes, and detailed, structured information like instruction manuals. However, he is critical of some well-known decks:

‘Many people think of *IDEO Method Cards* when they think about cards in a creative work setting... They are more like books without binding. [...] Arup’s *Drivers of Change*...cards contain a lot of information...It’s hard to use them in workshops as people get overloaded with information.’

Casais et al. (2016), who created *Design for Symbolic Meaning* (SIM) cards to help create

products that promote human happiness, give reasons similar to those mentioned above for choosing a card-based tool, but also note some potential weaknesses:

‘...a card set is a static format, which may suffer from lack of updateability and lack of dynamic interaction. Furthermore... use with none or few rules can be overwhelming or confusing, which may result in it being time consuming to figure out and put in practice. In addition, the card set format can oversimplify important information.’

According to their enthusiasts, therefore, card decks have many strengths as a design tool including:

- Facilitating creative combinations of information and ideas
- Providing a common basis for understanding and communication in a team
- Providing tangible external representations of design elements or information
- Providing convenient summaries of useful information and/or methods
- Are semi-structured tools between blank *Post-it* notes and detailed instruction manuals

Card decks may also have some weaknesses, including:

- Overloading users with too much information
- Over-simplifying information due to space limitations
- May be complicated for users to understand and apply
- Are difficult to change and update.

3 Reviews and classifications of card-based design tools

Given these many card-based tools for different purposes, there have been attempts to review and classify them, to help designers decide which to use.

One attempt is that by Miemis (2012) who lists 21 card decks which she categorised into: (Design) Principles & Processes; (User) Experience & Game Design; Communication & Learning; Visioning & Foresight; Ideation and Brainstorming.

Other online reviews of card decks include those by Donaldson (2010), who lists what he considers the ten best card decks to aid UX design, and Baldwin (2011), who reviews his five favourite decks for creativity, human-centred and UX design. Anderson (2012) lists 38 card-based tools classified into: Creative thinking; Design methods; Visual design; Gaming; Management/organisation; Psychology+Design and Social Design. But he includes a Miscellaneous category, reflecting the difficulty of classifying the large number of tools by then available.

3.1 A comparative analysis of card-based design tools

Online lists of card-based design tools and attempts to classify them by four reviewers were noted above. However, a literature search only revealed one previous academic paper, by Wölfel and Merritt (2013) that provides a comparative analysis of a sample of these tools. These academics analysed eighteen card-based design tools according to their purpose, function and characteristics.

They identified three broad categories of card-based tools (column 1 in Figure 3).

Figure 3: Classification of method cards for design, (Wölfel & Merritt, 2013: p. 483)

General/Repository tools, some of which provide inspiration and challenge designers to take another point of view. An example is *Oblique Strategies*. Other tools in this category function as ‘methods repositories’ and offload the task for designers of remembering the many available design methods. Examples of this type are the *IDEO Method Cards* and the *SILK Method Deck*.

Participatory design cards, such as *PictureCARD*, seek to develop empathy for the context, and engage designers and users in the design process. Others, such as *Questionable Concepts*, aim to promote debate between users and designers, while the *Ideation Deck* helps creative team exploration of design briefs.

Context specific/agenda-driven examples. This category includes cards focused on a particular agenda such as the *Design Play Cards*, which focus on designing for sustainability and the *Sound Design Deck* for acoustic expression in computer games.

Because Wölfel and Merritt only suggest three categories, classification issues arise. For instance, the *IDEO Method Cards* and the *SILK Method Deck* are classified as General/Repository tools, but it may be argued that their main purpose is to suggest methods for user participation in design. Conversely the *Ideation Deck* might better have been classified as a creativity tool in the General/Repository group.

Wölfel and Merritt’s naming one of its categories ‘Participatory design’ might also be questioned. It has been argued (e.g. by Luck, 2018) that genuine participatory design should involve, among other criteria, equalisation of power relations between all participants in a project, and not just user or other stakeholder consultation or involvement. Hence, we use the term ‘user participation in design’, where end-users are consulted or make an input, to describe how decks labelled by their authors as ‘participatory design’ tools such as *PictureCARD* and *Questionable Concepts* actually operate. Other decks labelled as participatory by Wölfel and Merritt (*Inspiration Cards*; *Visual Explorer Cards*) we would class as fostering ‘collaborative design’ in which the main aim is to enable different professions or experts to collaborate on a common project, even if they sometimes consider the needs of, or even involve, non-expert users (Zamenopoulos & Alexiou, 2018).

3.2 A new classification of card-based design tools

Despite the various classifications there are some common categories, including card decks for creativity and problem-solving; human-centred design and user participation; design methods; and specific domains such as game design.

To produce a classification based on a larger sample than Wölfel and Merritt's and builds on the previous classifications, we tried to obtain as complete an inventory as possible of card-based design tools. A starting point was the Deckaholic (2014) website, which provides details of 81 card decks in its online library. However, by inspecting the stated purpose and content of each deck, using the Deckaholic library's website links and other relevant websites, we identified 32 that could be considered as design tools. The remainder were cards to help or provide information in areas such as travel and sustainable living. We also drew on our own collection of card decks used in teaching and the online reviews by Miemis (2012) and others. We then completed the inventory via a systematic literature and internet search. For example, searching on terms such as 'design methods cards' found additional card decks, as well as publications, references and online posts about them, which were pursued until no new information was found. This provided a list of card-based design tools which eventually reached 155 decks. The inventory includes a few cases where one developer had created many decks: notably the *MethodKit* collection, nineteen of which we considered as design tools. Further searches of websites of images such as *Pinterest* could have yielded more decks, but we decided to stop when the same ones kept recurring.

We then analysed these 155 card-based design tools. We did this by carefully inspecting the card decks where we had printed or downloaded copies, or by obtaining information from the literature, websites and reviews of tools where we did not have a physical copy. This enabled us to identify each tool's main purpose or function and its content.

Our classification includes three core categories of design tools:

- **Systematic design methods and procedures** (18 card decks; 11.6% total). Systematic methods and processes to find, analyse and solve design (and innovation) problems. This category includes representations for different stages of the design process to help designers to work systematically from problem or brief to detailed solution (e.g. *SUTD-MIT Design Methods Cards*).
- **Human-centred design** (37 card decks; 23.9% total). Decks of methods to help designers focus on the users of a product, service or system considering their needs, wishes and requirements. This category included 18 general-purpose tools (e.g. *Innovating for People*) for human-centred design of any product, service or system (PSS). There were 19 decks for human-centred design in specific domains – 11 of which focused on digital design (e.g. *Design Axioms*); four on service design (e.g. *SILK Method Deck*); and four on other domains, such as production systems (e.g. *Layout Kit*).

- **Domain-specific design** (39 card decks; 25.2% total). This category provides methods, information or checklists for domains not covered elsewhere. The most common, with 12 decks, was for digital design e.g. of websites, apps, devices and interactive systems (e.g. *inSights Cards*), plus another 10 decks for computer game design (e.g. *Game Seeds*). (Human-centred digital design tools are categorised separately above.) Other domains were environmental design with eight decks (e.g. *The Landscape Game*); designing for sustainability, three decks (e.g. *Design Play Cards*); graphic design, two decks (e.g. *The Design Deck*); and designing for children, museums, crime reduction and international justice (e.g. *Metaphor Cards*), one deck each.

Our classification then covered card-based tools that are aimed at helping designers and designing, but included a number of decks that could also be applied in other fields, such as management, advertising and innovation.

- **Creative thinking and problem solving** (40 decks; 25.8% total). Half of the decks in this category (20) were tools for creative thinking for design tasks (e.g. *Design Heuristics*). The other half (20 decks) were general-purpose tools which could be used to help solve any type of problem, including design tasks, requiring creative thinking (e.g. *Intúiti Creativity cards*).
- **Team building and collaborative working** (14 decks; 9.0% total). Two of the decks in this category aimed to help create effective design or co-design teams (e.g. *Surviving Design Projects*). The other 12 decks aimed to facilitate team or collaborative working in any type of group situation, including design teams (e.g. *Totem cards*).
- **Futures thinking** (7 decks; 4.5% total). This category deals with awareness of change and planning or problem solving, based on trends or fact-based analyses of future scenarios. Three decks focused on design futures (e.g. *The Thing from the Future*) and four were general-purpose tools for thinking about the future, including for design tasks (e.g. *Drivers of Change*).

Figure 4a provides a visual overview of the proportions of decks in each of our six main categories and Figure 4b shows a more detailed breakdown of the main categories into discipline areas.

Creative thinking and problem solving 40 decks	Domain-specific design 39 decks	
Human-centred design 37 decks	Systematic design methods and procedures 18 decks	Team building and collaborative working 14 decks
		Futures Thinking 7 decks

Figure 4a: Classification of 155 card-based design tools. The area of each block represents the proportion of card decks in each of six main categories

Figure 4b: Breakdown of the six main categories of card deck into domains or discipline areas

There are three cross-cutting groups of card decks that overlap our six main categories. These comprise tools for design or other projects which aim: (a) to facilitate *direct end-user participation* (e.g. *Layout Kit*); (b) to help *designers consider user abilities, needs and wants* (e.g. *DSD Cards*); and (c) to aid *collaboration between different experts or professions* (e.g.

DSKD Method Cards). Although there was some blurring between these groups, we identified 24 decks (15.5% total) whose main aim is to enable direct user participation; 18 decks (11.6% total) which help designers consider user needs; and 54 decks (34.8% total) which mainly aim to facilitate expert collaboration.

We also found decks intended for use in two related domains: **Learning design** (four decks) to help create curriculum and training materials; and **Marketing** (five decks) to help develop promotion and marketing campaigns. We considered that these decks were insufficiently design-focused, and so were not included in our inventory.

3.3 Validation of the new classification

Since the above classification was based on a comprehensive inventory of card-based design tools, we considered it to be fairly robust. Nevertheless, to check its validity, we selected a sample for more detailed analysis.

For this analysis we selected 30 card decks that represented the six main categories in our classification, were often mentioned in the literature, and of which we had a complete set. The sample comprised 15 decks from our original collection used in teaching, etc. plus a further 15 obtained from their authors or printed from the deck's website (the sample is indicated by single and double asterisks in the Appendix A. Supplementary data).

We then examined the content of every card and discussed whether and how the individual cards and each deck fitted our classification. We considered that all the decks fitted one of our six categories, but some cards within the decks better fitted other categories. This is shown in Figure 5, in which the deck's main category is shown in the upper segment of each panel and categories that individual cards from the deck fitted are in the lower segment(s) of other panels.

Figure 5: The 30 selected card-based design tools classified by the deck's main purpose or function (upper segments) and the purpose or function of individual cards within the deck that better fit another category (lower segments)

The detailed examination also showed that some decks fitted a general category, but were intended for application in specific domain. For example, the *SILK Method Deck* concerns human-centred design, but focusses on the design of public services. Or the *TRIZ Solution Cards* aim to promote creative thinking, but mainly for engineering problems. So, we could have classified *TRIZ* as Domain-specific design (engineering). Classifying *TRIZ* as Creative thinking and problem solving, means that our classification is primarily based on a tool's main purpose and function, whether it applies to designing in general or focuses on a specific domain.

4 How are the card-based design tools supposed to work?

Examining the selected card decks and individual cards in each deck, with any accompanying instructions, also provided an understanding of how the tools are supposed to work. Möller (2014) groups card decks based on what they are supposed to do, namely: Framework cards (task checklists); Index cards (digests of information or methods); Libraries cards (useful data); Strategy cards (thinking strategies); Grid cards (selection criteria); and Visual inspiration cards (pictorial prompts). Based on our and Möller's analyses, we identified five types and mechanisms.

4.1 Cards that provide prompts to stimulate creative thinking

The principle underlying these types of cards is that people can be triggered out of their normal thinking patterns by, sometimes unusual, associations, suggestions or actions written and/or illustrated on the cards.

For example, some of the *Oblique Strategies* cards offer relatively straightforward suggestions such as ‘*Look at the order in which you do things*’ or ‘*Turn it upside down*’. Other cards contain more cryptic suggestions, for example ‘*Cascades*’ and ‘*Gardening not architecture*’ to trigger ideas.

The U101 *Design Thinking* cards provide prompts with images, based on creative thinking research, to aid innovative thinking, such as ‘*take a walk*’ and ‘*be playful*’ (Figure 6).

Figure 6: Four of the U101 Design Thinking Welcome Pack Cards, (Open University, 2010)

The *Design Heuristics* cards offer 77 established technical principles, derived from research on the insights of experienced designers, to help generate new concepts in engineering/product design. For instance, one card suggests ‘*Apply existing mechanism in a new way*’ and another ‘*Convert for a second function*’ (see Figure 10) and both give examples of how the principle might be applied in practice.

4.2 Cards that summarise good design practice know-how or information

These cards provide digests of potentially useful information for specific design tasks, such as information on accepted good practice in web or game design, in a handy, shareable and combinable form. For example, in *The Art of Game Design* the ‘*Lens of visible progress*’ card advises that in a computer game ‘*players need to see that they are making progress when solving a difficult problem*’ and provides questions to check a game for effective player progression.

The Design Deck: A playing-card guide to graphic design provides an illustrated guide, distilled from the best graphics books, about how to produce good graphic design, including cards on typography and colour theory, while the *DSD Cards* provide information on the abilities and wants of children in different age groups and offer design tips for meeting them (Figure 7).

Figure 7: Example DSD (Developmentally situated design of products for children) card (Antle & Bekker, 2013)

4.3 Cards that summarise design methods

These cards provide summaries of design methods, which might be generally applicable or specific to particular domains.

The *iD Cards*, for instance, provide images and descriptions of how a new product may be modelled and represented as it is developed from idea to detailed design (Figure 8). For example, card 8 is ‘*Prescriptive sketch. Informal sketch for the exploration of technical details such as mechanisms, manufacturing, materials and dimensions.*’ The *iD Cards* also provide guidance on which representations are best suited to the concept, design development, embodiment design and detail design stages and so could also be considered as providing summaries of a general design process for new product development.

Figure 8: Four of the iD Cards which provide summaries of different representations suited to different stages of the design process, (Evans & Pei, 2014)

Another example, of this type from the *IDEO Method Cards* is ‘Empathy Tools’, which suggests using devices like clouded spectacles and weighted gloves to allow designers to experience how people with disabilities experience using products and systems to design new or improved versions. IDEO used this method, for example, when designing a home health monitor for people with reduced dexterity.

4.4 Cards that provide concepts for specific design problems or domains

An example of this type of tool are the *Design with Intent* cards, which provide ideas and solutions for influencing human behaviour through design to improve usability, safety, security, health or sustainability. Figure 9 shows two cards from the deck, which offer examples of designs that guide people to operate a product correctly.

Figure 9: Two of the Design with Intent ‘Perceptual lens’ cards, (Lockton, 2010)

Another card of this type from the *Design Play Cards* for facilitating eco-design is ‘Easy

Disassembly', which notes that laptop computers can be designed to be disassembled, to increase the likelihood of repair and recycling, by having standard screws and labelled materials.

4.5 Cards that provide checklists to aid specific design tasks

This type of deck has cards listing topics, ideas, questions, observations, and research findings, which when used individually or in combination, may help design new or improved products, services or systems. Most of the *MethodKit* range of decks fall into the checklist category. For example, *MethodKit on Web Development* contains 55 cards, each with a key issue to consider while building a website, such as its Functionality and Browser compatibility. The *MethodKit for Kitchen Design* contains 59 cards, each representing a significant topic to consider when designing a kitchen, such as Workspace; Appliances; Fire safety; Budget.

In the Futures thinking category, the *Drivers of Change: Water* card deck includes a 'Water consciousness' card that provides information on water scarcity and use per capita in various countries and provides suggestions for reducing water consumption by redesigning toilets, appliances and showers.

5 Evaluations of card-based design tools

How useful do designers and other users find card-based tools? Do the tools help produce more innovative or better designs? To answer these questions, it is necessary to review available information on their development, testing and practical application.

Most of the card decks have been created by academics or by design/management consultants, with a few developed for in-house use by corporations such as IBM. This means that evidence on the value of cards is typically found in publications by the academics who created the deck reporting on its development and testing, often using students; or in online reports on tool use by the consultants who developed it or when working with clients. Typically, therefore, the tools were tested by their authors, so their findings cannot be regarded as fully objective. Very few independent, scientific trials have been conducted comparing the tools with each other or with other methods. It is hard therefore to establish whether the card-based tools help to produce more innovative or better design outputs. This is especially so given design outcomes depend on factors other than the use of a particular tool. Hence evaluations often consist of feedback from users on whether they liked or benefitted from using the tool rather than design outcomes.

The sections below summarise some of the evaluations that we found.

5.1 Developmental tests of card-based tools

Card decks are often developed by successive testing with users. An example is the *Mixed Reality Game Cards*, which aim to help designers create and develop ideas for mixed reality games (such as *Pokemon Go*) that combine digital and real-world elements. They were developed through three versions via six tests with users, including game design students and professionals and people who had never developed a computer game before (Wetzel et al., 2017). Feedback from the user groups on the first version stated that the cards ‘*simplified brainstorming, broke the ice, were easily accessible, sparked creativity, and lowered the barrier for proposing ideas*’. The main criticisms were this version’s basic graphic design and the amount of text on the cards resulting in ‘*information overload*’. A test on the third version with a team inexperienced in mixed reality game design indicated that although the cards helped them generate ideas, they found it challenging, suggesting that domain knowledge may be needed to produce worthwhile ideas in such a specialised field. Nevertheless, the tool’s creators concluded ‘*the cards have proven to be an effective tool to shape the collaborative design of mixed reality games*’ (p 202).

5.2 Trials of developed card-based tools

Applying a fully developed deck to an exercise or a real-world task was the most common way that the tools were evaluated. For example, how the *PictureCARD* deck was applied was mentioned in section 1 and other trials are described in the literature (e.g. Halskov & Dalsgård, 2006; Mueller et al., 2014). Below are three more.

5.2.1 DSD Cards

The *DSD Cards* (Figure 7) provide information on the physical, cognitive, etc. capabilities, needs and wants of children and offer design tips for satisfying them (Bekker & Antle, 2011). To test the cards, the developers observed student design teams undertaking an early concept development task and two redesigns of an existing solution. The first case was an initial concept development of a tangible user interface to give 10 to 12-year old boys a sense of connectedness. The second case was a redesign of an older children’s table-top sustainability game to make it accessible for children of all ages. The third case was a redesign of an adult online game to make it suitable for children. The students were observed during the tasks and afterwards interviewed about the value of the cards. In all three cases, it was observed that the cards ‘*helped frame and reframe the problem*’. Images and speech bubbles on the cards about what children enjoy doing helped stimulate ideas, and information specifying children’s

capabilities at different ages usefully constrained design solutions. The card's creators conclude that the tool *'provides designers with a flexible design tool that makes theoretical knowledge about child development accessible to designers'* (p 2539).

5.2.2 Questionable Concept Cards

Another interesting test was that of the *Questionable Concept Cards* in workshops to develop concepts for new financial services for elderly people (Vines, et al., 2012). A group of over eighties were presented with cards containing innovative or provocative concepts, such as a thimble that displays a person's PIN number when placed on their finger or a handbag that explodes if stolen. These were discussed by the group, resulting in criticisms of existing financial services for the elderly and of the given 'questionable concepts'. Nevertheless, the discussions led to new service ideas and improvements on the concepts. *'Whilst the immediate reactions of some participants suggested a significant amount of hostility towards many of the ideas, the discussions following these initial responses were very productive'* (p 1173). For example, when it was explained that the PIN thimble would only display when it recognised the owner's fingerprint, participants then considered it *'a good idea'* and discussed how it could be improved.

5.2.3 DOC Method Cards

Watson (2013) describes a real-world application of the *DOC Method Cards* developed by the Designing Out Crime research centre, University of Technology, Sydney. The project concerned finding ways of reducing crime in a Sydney hot-spot. Methods summarised on 14 DOC cards were employed to address the problem. These included *'Theme analysis – the dominant themes were that partygoers weren't looking for trouble, but an exciting night out;* and *'Frame Creation – if the area were treated like an event space the problems associated with large alcohol intake and absence of infrastructure would be addressed'*. Having used cards to help analyse the problem, the 'Design Exploration' cards helped generate solutions, including street wardens, portable urinals, free water, integrated transport and chill-out zones, which were subsequently adopted by the City of Sydney.

Even though all these trials were carried out by their developers, they indicate that card decks can provide valuable ways of analysing design problems, generating and developing worthwhile ideas and sometimes getting them implemented.

5.3 Comparative tests of card-based tools

As noted above, there have been very few independent, controlled and/or comparative tests of these tools; below are the only examples we could find.

5.3.1 Insights v MethodKit v control (no cards)

Bornoe et al. (2016) tested the use of different decks with 44 Danish undergraduate informatics students given the task of redesigning a soccer team web-shop. Different groups used Fabrique's *inSights* cards, which provide detailed information on good web design practice; the *MethodKit for Web Development*, which only offers a checklist of requirements; plus a control group with no cards. Afterward, three web developers assessed the quality of the student teams' suggestions.

The authors found no obvious connection between card type and their perceived usefulness or the quality of the redesign suggestions. Even the group with no cards provided one of the best suggestions. Nevertheless, the findings indicated that the card decks helped to generate ideas, provoked participants to consider aspects other than personal knowledge and preferences, kept the groups focused, and helped progress discussions during the ideation phase. However, the cards did not compensate for the students' limited web design experience. Especially, understanding the value of the cards and how to implement them was found to be a challenge, suggesting that more instruction, facilitation or practice would have helped.

5.3.2 Design Heuristics v control (no cards)

In another educational trial, the *Design Heuristics* cards (described in section 4.1) were tested on first year American engineering and industrial design student groups set the task of designing a portable solar-powered cooking device given a sub-set of 12 of the 77 cards (Daly et al., 2012; Yilmaz et al., 2012).

CONVERT FOR SECOND FUNCTION

26

CONVERT FOR SECOND FUNCTION

26

Create multiple stable states of the product, where each state defines a separate function. Transitions between these states can be achieved through rearranging, reorienting, and attaching or detaching components. This can allow multiple functions to be incorporated into one product.

© Design Heuristics, 2009

AKIRA TABLES

Coalesce Vecta

This table features a folding top that can flip up or down, making it useful as a room divider.

GRAVITY BALANS

Peter Opsvik

This recliner has multiple stable stages, allowing the user to kneel upright, or recline by leaning back and finding a balance point.

Figure 10: Sample Design Heuristics card (front and back)

Source: Design Heuristics 77 cards, <https://www.designheuristics.com/wp-content/uploads/2012/08/Design-Heuristic-Workshop.pdf>

For the engineering students, the results showed that concepts created without the cards were less developed and were often replications of known ideas or minor changes to existing products. Concepts created using the cards resulted in more developed, creative designs, although it was noted that practicality of the designs were not tested. Some students readily applied the heuristics, while others struggled to understand how to apply them (Daly et al., 2012).

Likewise, the results from the industrial design students indicated that using *Design Heuristics* cards helped students generate more creative, diverse concepts. Concepts with heuristics evident were more complex and offered additional features, such as considering how the product would be used. Concepts without applying heuristics were often minor modifications to existing products (Yilmaz et al., 2012).

The authors of these controlled studies conclude that *Design Heuristics* cards, given brief instruction, offer a sound method in ideation for novice designers leading to the generation of designs judged more creative and diverse.

5.3.3 Design Heuristics v brainstorming

Leahy et al. (2018) found similar results from a test by 185 engineering students of *Design Heuristics* cards versus brainstorming as a way of overcoming design fixation. After brief instructions to and practice of both methods, individual students were given the task of designing a spill-proof coffee cup, or a car bicycle rack, when provided with an existing design. After analysing the outputs of the brainstorming and *Design Heuristics* sessions the researchers

conclude: ‘...using an alternative idea generation method, such as Design Heuristics, may be helpful in moving the designer away from initial ideas to consider alternatives.’

However, the researchers found that:

‘Brainstorming resulted in more ideas than *Design Heuristics*. The *Design Heuristics* method...required more learning time...students were already familiar with brainstorming, so may have found that method easier to use’ (p 2774).

These few comparative tests indicate that card decks can be an effective tool for helping to create novel design ideas and for facilitating the design process when working in teams, but novice designers may require more instruction, facilitation or practice to apply them effectively.

5.4 Practical applications of card-based tools

Once established card decks may be used in real-world applications and the results are occasionally described in papers, online posts, etc. Here are some examples.

5.4.1 CARD

The creators of *CARD* (Collaborative Analysis of Requirements and Design) used the tool at Bell Communications in the 1990s to improve two software systems – a source code maintenance and a graphical layout system – by obtaining user feedback and ideas. A post-project survey found that:

‘Users had high confidence that *CARD* supported them in making effective comments, and in communicating their views... They also believed that the cards helped them to check the analyst’s understanding of the users’ views. Finally, users indicated that they had found the sessions interesting, valuable, and enjoyable, and that they would like to participate in them again.’ (Tudor et al., 1993: p. 52).

According to its authors, the *CARD* tool seems to have allowed more effective communication between users and developers than the previous informal methods used in the company.

5.4.2 Design Heuristics

The organisers of the *Design Heuristics* student trials described above also tested the cards in a company with professional engineers who applied the cards to their current project – an (unspecified) outdoor consumer product – in an innovation workshop. The researchers conclude

that the trial:

‘...provides evidence for the success of heuristics in generating novel solutions and overcoming design fixation. The designers reported that they felt the cards stimulated novel thinking even though they had been considering these product designs for many years. After the study, the design team stated they felt the heuristic cards were effective, forced them to stay on track, and helped to focus their attention on one topic at a time’ (Yilmaz et al., 2011: p 6).

5.4.3 IDEO Method Cards

Each of the 51 *IDEO Method Cards* provides a short example of how IDEO applied the method in a real project. An example, outlined in section 4.3 (Cards that summarise design methods), is ‘Empathy Tools’. Another example, ‘Behavioral Archaeology’ suggests looking ‘*for the evidence of people’s activities inherent in the...organisation of places and things...to reveal how artefacts and environments figure in people’s lives...*’ Applying the method showed that people organised multiple work tasks by stacking papers in piles on their desks, which led IDEO to design a new item of office furniture. The existence of such examples of application, at least by IDEO itself, could be viewed as evidence of the practical value of this tool. Indeed, IDEO estimates that between 2003 and 2011, when an iPhone app version was launched, over 10,000 card decks had been sold or distributed.

Although created for human-centred design, the IDEO cards have been used for other purposes such as creative thinking and problem-solving. One enthusiast, (Pelkey-Landes, 2009), says:

‘Clients report using the tool to explore new approaches to problem-solving, gain perspective, inspire a team, turn a corner, try new approaches, and to adapt and develop their own methods... I can pull the deck of the shelf, rummage through and look for an idea that fits my need... I can put them in the middle of a table and let a group of people paw around in them.’

5.4.4 UX Cards

Another card deck, now online, that seems to have value for designers are *UX Cards*, which like IDEO’s cards, are a set of practical design methods, in this case for user experience design. Giola (2014) describes how one of the long-established methods, ‘Card Sort’, was used for interface design of a supermarket self-service checkout. Users sorted cards containing names of different foods into groups to identify the best food categories for the checkout’s screen.

Another user, Baldwin (2011), a UX designer, writes,

‘...when I was struggling for ways to approach a workshop with a client or for ideas on how I could solve a problem, nForm’s *UX Cards* were often a point of reference... Just pulling a random card and talking about the method can spur ideas when a team is having a hard time determining an approach.... Another use is in explaining what you’re planning to do with clients or stakeholders. Rather than just saying you’re going to create a concept model, you can hand them a card showing what a concept model is and why it is used.’

5.4.5 *The Art of Game Design*

Arcila (2013), a games designer, writes about the practical value of *The Art of Game Design*. The ‘*Lens of Visible Progress*’ card, described in section 4.2, for example,

‘...was very useful when I was designing my game *miniQuest: Trials*... I wasn’t clearly conveying the progress the player was making... That’s why I designed a playable level selection screen where you could unlock doors, and why I also changed the colors of each floor to make the progress more visible.[...] After several years of using these cards with students... I’ve found that it’s an excellent tool that sharpens your ability to look further as a game designer.’

6 Discussion and conclusions

Numerous card-based design tools have been produced. The first few, produced from the 1950s to the 1980s, mainly aimed to stimulate creative thinking. Then in the 1980s and 1990s a few card-based tools were created to facilitate user participation in workplace and IT systems design. An upsurge occurred after 2000 when numerous card decks began to be produced, not only for general creative thinking and problem solving but to provide methods for human-centred design, especially of digital systems; for specific purposes such as eco-design and game design; and to provide guidance on systematic design and team working. We found 155 such card-based design tools, and there are undoubtedly more.

Other authors, notably Anderson (2012), Miemis (2012) and Wölfel and Merritt (2013), have attempted to classify the tools by their main function based on samples ranging from eighteen to thirty-eight. We have produced a new classification based on our comprehensive survey of card-based design tools and validated it by a detailed examination of individual cards and decks in a sub-sample of 30 tools. While there are similarities between our classification and those of

others, given our larger sample, we consider our classification to be robust, while recognising that any system is based on judgement.

The largest proportion of decks aimed to facilitate creative problem solving (25.8%), followed by tools for domain-specific designing (25.2%) and for human-centred design (23.9%). There were a smaller proportion of decks to aid systematic design processes (11.6%), team working (9.0%) and futures thinking (4.5%) – Figure 4a. Analysis of the sub-sample revealed that, while all decks fitted one of our six categories, some individual cards fitted another category better – see Figure 5. Many decks fitted a main category but were intended to be applied in a specific domain or discipline – Figure 4b. There were also three categories for different forms of participation or collaboration that occurred within our main categories. These aimed to enable direct end-user participation (15.5% total); to help designers consider the abilities, needs and wants of users (11.6% total); or mainly to facilitate professional or expert collaboration (34.8% total). Understanding where the decks fit within these various categories should help designers decide which tool might be appropriate for particular tasks.

Despite the large number of card-based design tools, there are some gaps in their coverage. Domains with few existing tools include architecture/built environment (four decks); sustainable design (three decks); graphics and transport design (two decks each). Developing more tools for these domains could be a fruitful area for design research.

We also found that there are different ways that card-based design tools are supposed to work; from providing creative thinking prompts and digests of good practice or design methods, to offering checklists of issues to be addressed and concepts and solutions for specific design problems.

It is argued that card-based tools have advantages over other media for helping to design (e.g. Rothstein, 2012; Möller, 2014). The evidence and feedback from trials and applications of the tools indicate that their advantages stem from certain characteristics of cards. They are engaging objects which summarise information, methods, or good practice in a handy form that designers can absorb and act on; they can be shuffled and combined in multiple ways; serve as a common reference for teams of designers, users and others to facilitate discussions; can provide structure to a design process; and offer words and images to widen the search space and overcome design blocks. Thus, an important strength of cards is their being a physical artefact that people can interact with. This also helps explain why significant effort has often been invested in their graphic design to make them attractive to own and use.

Deng et al. (2014) provide a summary of advantages of cards as a design tool.

‘In studies of design cards, design researchers have found cards can help structure design discussions, ensuring a design space is viewed from different perspectives. Cards can help speed up the refinement and iteration of ideas... The information on the cards provides designers with a common vocabulary... The small physical form of cards affords physical manipulation. Cards can serve as a physical reference during design discussion, facilitating communication and shared understanding’ (p. 696).

The use of a physical tool can be viewed as ‘going against the grain’ of everything digital, although, perhaps ironically, a high proportion of card decks (33 or 21.3%) aim to help the technical or human-centred design of digital products and systems, including websites, apps, interactive devices, computer interfaces and games. Hence unsurprisingly, some of the tools are now also available as apps or online.

What do users think of card-based design tools and do they help produce better or more innovative designs? User trials and feedback indicate that designers and others seem to like card-based tools and some of the decks have been sold or downloaded in large numbers. Negative feedback seems mainly concerned with difficulties in understanding how to use some decks and puzzlement or overload if individual cards contain too little or too much information.

Very few independent, scientific trials of card-based design tools have been conducted. Student tests of two web design decks, versus a control group without cards, showed that while the cards did facilitate the group design process and help them generate more ideas, there was little difference in the quality of the ideas produced (Bornoe et al., 2016). Engineering and industrial design student tests of the *Design Heuristics* deck versus a control group or brainstorming clearly showed that this tool helped generate more, and more innovative, ideas and concepts (Daly et al., 2012; Yilmaz et al., 2012; Leahy et al., 2018). Trials and applications of the creativity decks seem to enable novice and professional designers or users to generate more innovative ideas, although their practicality may be unproven. Applications of card-based tools for design participation also seem to enable non-expert users and designers to communicate effectively with each other (Tudor et al., 1993) or facilitate design collaboration between professionals (Halskov & Dalsgård, 2006). But while the different tools can promote creativity and communication, choose appropriate methods or access specialist information and good practice, they cannot compensate for lack of domain knowledge and experience where this is required. Novice designers, especially, sometimes struggled to use cards and good instruction, facilitation or practice seems to be essential.

The limited evidence from applications of card-based tools by practising designers and

consultants is that decks most likely help to produce worthwhile design outcomes are those which stimulate creativity or facilitate user participation at the early stages of design, and those which summarise human-centred and domain-specific design methods, or good practice guidelines, which can be drawn upon through the design process.

However, almost all evidence on the value of these tools comes from the academics, designers or consultants who developed them. Hence more work needs to be done in evaluating these tools in independent, scientific trials, as well as to check the validity of the examples of products, services or systems said to be the result of using the tools. Thus, one of the authors of this paper was pleased to be asked to review a submission to *Design Studies* reporting on a protocol analysis of the multidisciplinary team design process with and without use of a card-based design tool.

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Appendix A. Supplementary data

Supplementary data to this article (Table: Inventory of card-based design tools by year, main category and discipline focus) can be found online at

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PLEASE SEE APPENDIX TABLE FOR FULL DETAILS OF THE 155 CARD SETS:

This is available as a separate file within www.oro.open.ac.uk/61472