Revisiting the Role of User Research in Design Creativity

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ABSTRACT

Despite the claimed relevance of user research for design, we know little about how it impacts creativity specifically. Our objective is to establish a foundation for answering this question. We review empirical findings from related domains to examine how the value of user research is linked to design creativity.

CCS CONCEPTS

• **Human-centered computing** → HCI design and evaluation methods; User studies; Laboratory experiments.

KEYWORDS

User Research; Design; Creativity; Interaction Design.

1 INTRODUCTION

In this paper, we explore the relationship between two concepts that lie at the core of Human-Computer Interaction (HCI), namely *user research* and *design creativity*. Understanding users and their context is generally considered to be of critical importance, and the benefits of user research have been emphasized in a range of canonical contributions [17, 22, 27]. While the general consensus seems to favor the deployment of user research in interaction design, this long-lived understanding has been challenged when it comes to designing innovative products such as virtual and physical interactive systems. As a case in point, this stance shines through in Jobs' famous quote on Apple refraining from doing market research, "no

market research could have led to the Macintosh or the personal computer" [40, 43]. Similarly, Norman & Verganti [31] have argued that human-centered design seldom leads to radical innovation. One way of construing these propositions is by reference to the relationship between user research and creativity.

Just as it goes for user research, creativity is acknowledged as an important aspect of interaction design; in part because creativity training and derived skills can be useful for exploring a wide range of potential solutions to a design problem, in part because design is often expected to result in the introduction of something novel into the world. Nelson & Stolterman thus articulate design practice as "the ability to imagine that-which-does-not-yet-exist, to make it appear in concrete form as a new, purposeful addition to the real world" [29]. In the ECCE conference series, studies into design creativity have mainly focused on designing for ideation [8], social media as collaboration tools [2], and tools for creative writing [7, 18, 19].

Despite the apparent importance of user research for creativity, we have surprisingly little empirically grounded knowledge about *how* user research influences creativity in design. Does user research lead to higher levels of design creativity? How much user research is advisable in order to attain a certain level of design creativity? How might we measure (if at all) the relevance of user research for design creativity? Exploring such questions is equally relevant for design research and practice. Design practitioners often face important decisions about how much time to dedicate to user research, for instance when scoping and planning projects, and about the type of user research to bring into play in specific activities during a design project. An even deeper understanding of the relationship between user research and creativity in design can therefore have implications on both a theoretical and a practical level. While this relationship is clearly complex, we find it necessary to begin by casting a sturdier empirical foundation for understanding and discussing it in order to inform future research.

Our long-term agenda is to examine the complex question of *how user research influences design creativity*. However, as we shall examine in more detail here, this is a highly complex question, and so a necessary first step is to establish the proper grounding. To this end, we conducted a review of the related empirical literature and the argued potentials and limitations of user research.

2 LITERATURE REVIEW OF USER RESEARCH AND RELATED WORK

In this first part, we present a definition of user research, including the one we adhere to throughout this paper. We then provide an overview of existing empirical evidence for the impact of user research. To further contextualize the topic of user research in design, we offer a brief overview of creativity in design. We end this section with a juxtaposition of the potentials and limitations of user research.

2.1 Defining User Research

In general, and as pointed out by others [5] before us, the use of different terms describing the same or related concepts may often complicate the establishment of a solid overview or even a scientific consensus. One reason is the heterogeneity of disciplines that, to a varying degrees, rely on the *consideration of a user*[1] This may result in relevant empirical evidence being scattered across outlets from the *Empirical Software Engineering: An International Journal* [1] across *Management Science*[45] and the *CHI proceedings* [20, 21] to *International Journal of Technology and Design Education* [9, 11], to name but a few publication venues. Consequently, different traditions will tend to employ various terms to discuss often overlapping, but slightly different, terms such as 'user involvement' as opposed to 'lead users.' Both denote some user part-taking, but may arguably be distinguishable based on the proficiency or competence exhibited by the user.

Even in HCI as one of the core disciplines to employ user research, the definition of user research is vague or even absent. Lazar et al. state that "user research is also a broader term that may include elements of design and development, such as personas, user profiles, card sorting, and competitive research that generally might not be considered 'research' by those who consider themselves researchers" [26, p. 143]. Although no clear definition is given, Cooper et al. emphasize that "user research is the critical foundation upon which your designs are built" [12, p. 73]. A fundamental disagreement is found when comparing user research to the term 'usability testing,' insofar as Lazar et al. state that "usability testing is often known as 'user research'" [26, p. 263], whereas Cooper et al. argue that "usability testing is also not the same as user research" since "user research must occur *before* ideation, usability testing *following* it" [26, p. 143, orig. emphasis]. Consulting other HCI textbooks e.g., [15, 36, 41] does not serve to conclude the discussion, as they do not explicitly mention the term 'user research' (based on a full-text search). Therefore, we subscribe to the understanding of user research as implicitly outlined by Cooper et al.[12], since this is also in alignment with the definition provided by the Interaction Design Foundation[2].

2.2 Empirical Evidence from Related Studies

Although the exact definition of user research remains contested, much research has been published on related topics such as usability testing, participatory design, and user involvement. The reviewed literature comes in the form of both meta-reviews and single studies

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and arises from various disciplines such as management, design, and HCI research.

Kujala [24] provided a review of user involvement and its effect on system success (as defined by a broad range of criteria) and concluded that "[u]ser involvement is clearly useful and it has positive effects on both system success and user satisfaction". Involvement in some cases also comes in the form of usability activities, user participation, and tests, and, as noted, "it is more difficult to prove empirically the cost-effectiveness of user involvement in gathering user needs before a prototype exists" [24]. Subsequent work by Kujala et al. [25] investigated the role of direct contact with users in relation to requirements quality and project success, underlining that while early user involvement is rare, it seems to be a powerful way of improving requirements quality and project success. Interestingly, the authors found no statistically significant direct relationship between user involvement and project success. A correlation was only found when the requirements for the project were based on real information on users, which lead the authors to the aforementioned conclusion [25].

Much similar to Kujala [24, 25], Bano and Zowghi [5] provided a systematic literature review of user involvement and system success in software development. They also addressed the inconsistencies in defining user involvement and project success, and how conjugating different terms and practices might render the general image opaque. In total, 87 papers from 1980 to 2012 were reviewed to conclude that overall, 68 percent of the publications seemed to show a positive correlation; however, due to the said issues, the results were not viable for a meta-analysis and a summarizing conclusion [5]. In parallel to Bano and Zowghi [5], Abelein and Paech [1] conducted a meta-analysis on literature of the relationship between user participation (and involvement) and system success. They found an overall positive correlation. This analysis was done by collapsing multiple sub-categories of variables such as developers' attitude toward users, users' abilities and involvement in the parent category of Human Aspects [1].

It is well-established in *innovation* research that users, not manufacturers, are often the first developers of products and services that later become commercially viable (e.g., Shaw [39]). Here, we subscribe to a general, unifying definition of innovation as proposed by Baregheh, Rowley, and Sambrook [6] based on their discernment of approximately 60 different definitions of innovation in the period 1934-2008. Their synthesizing definition suggests that "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (p. 1334). As an influential contribution to understanding user involvement in innovation, von Hippel [45] argued for a special type of user group–*lead users*. This refers to a specialized group of highly skilled users with profound knowledge about a given product. Lead users face needs in the market place months or years before the bulk of general users, and so they experiment with a given product to obtain an individual solution from which they themselves will benefit greatly. Lead users, therefore, are more likely to innovate than any other user group as documented empirically (e.g., [28, 44]). Lead users' extraordinary potential for innovation

led von Hippel [46] to advocate the idea of 'democratizing innovation' in the sense that companies and organizations are likely to benefit from involving lead users in the innovation process.

The term '*fuzzy front end*' is often used to describe the early phases of product innovation, but has also been used in the realm of design. In this context, Conradie et al. [11] explored the impact of end-user involvement in the earlier stages. Student designers tasked with redesigning a time-tracking device in an industrial manufacturing context were allocated to either a control group or a group with a visually impaired end user. Contrary to the authors' expectation, evaluation using the Consensual Assessment Technique [3] on the outcome yielded no difference between the two groups on either of the three criteria (user value, originality, and feasibility). In their discussion of the results, the authors pointed out that the benefit of user involvement has previously been realized directly through the ideas of the user, not through a group of designers translating them into concepts [11].

2.3 Creativity in Design

Arriving at a successful design solution often means attaining some level of creativity in the final design (see e.g.,[13]) This makes it highly relevant to explore exactly how user research affects design creativity. The creativity research community generally agrees that creativity requires *originality* and *effectiveness*. These criteria are sometimes also referred to simply as novelty and usefulness [37]. Establishing a clear understanding of creativity is critical because "[w]ithout a clear definition, creativity becomes a hollow construct-one that can easily be filled with an array of myths, co-opted to represent any number of divergent processes, and further confuse what is (and is not) known about the construct" [33]. Consequently, Plucker et al. [33] proposed the following definition, which synthesizes most current suggestions in a way that is suitable for both empirical and theoretical studies. This means that we understand creativity as the "interaction among *aptitude, process, and environment* by which an individual or group produces a *perceptible product* that is both *novel and useful* as defined within a *social context*" [33] (p. 90, orig. emphasis).

Given the detailed, yet aptly generic view on creativity that this definition suggests, we argue that this understanding is equally appropriate in design. Design can be construed as an inherently creative activity in that it is concerned with bringing something novel and useful into the world. In the words of Löwgren & Stolterman, "To design is to create something new."[27]. Creativity is not only a concern when it comes to the product of design, but even more so when it comes to the process of designing. Design processes typically encompass the development and exploration of a range of ideas for potential outcomes, as designers shift between divergent and convergent modes of thinking and acting to understand and explore the opportunities and constraints of the design space as they move towards a final product. Although the relevance of creativity in design is well-established (see e.g., [10, 14]), it is often seen as rather difficult to articulate clearly. To help elucidate this complexity, Askland, Ostwald, and Williams [4] proposed (at least) two competing conceptualizations of design creativity. The first is a positivist paradigm largely based upon Simon's [42] seminal work on design as a rational problem-solving process, and another

paradigm informed by Schön's [38] work on reflective practice in the sense that design is a "reflective conversation with the situation". Informed by these two main traditions, Askland et al. [4] argued for two conceptualizations of the design process-a descriptive, linear model (e.g. [23]), and an integrative systems view in which problems and solutions co-evolve [16]. Rather than adopt either of these positions unconditionally, we find it more relevant in the present paper to direct attention to the outcome of the creative design process. Consequently, and based on the above definition of creativity by Plucker et al. [33], we understand design as "the ability to imagine that-which-does-not-yet-exist, to make it appear in concrete form as a new, purposeful, addition to the real world" [29].

2.4 Revisiting the Debate on User Research

The empirical evidence for the impact of user research on design has contributed to, but not settled, the debate about to what extent user research is useful for design creativity. To provide a more in-depth outline of the motivation behind this paper and highlight the importance and complexity of the the relationship between user research and design creativity, we revisit the two dominating perspectives and their arguments either for or against the value and relevance of user research in design in general and its impact on design creativity in particular.

2.4.1 Potentials of User Research. "The group splits into pairs to find out first hand what people who use, make, and repair shopping carts really think," the speaker announces, accompanied by the pictures of two designers listening, observing, and taking notes in front of shopping carts in a mall setting [30]. This snippet stems from a famous clip from ABC Nightline's segment on IDEO's so-called 'secret weapon for innovation' and demonstrates in an entertaining manner the striking appeal of understanding the users and the context for which one is designing. This idea of understanding the users definitely goes beyond the design industry, here exemplified by the influential Palo Alto-based design consultancy firm that is perhaps most widely known for inventing the first Apple Mouse. The wider relevance of user research in academic and educational contexts is evident from Preece, Sharp, and Rogers' canonical book *Interaction Design: Beyond Human-Computer Interaction* [34], which clearly states the first of four basic design activities to be Establishing Requirements. This involves "understanding people and what they do" [34]. One of the rationales behind this particular phase is to get the design *right* and to minimize the cost of errors later in the creative design process. The activities in this phase most commonly take the form of questionnaires, interviews, focus groups, and direct observations, etc. [34].

A similar, well-known example of this perspective is that of Contextual Design, which is an "approach to designing products directly from a designer's understanding of how the customer works"[22]. This is important because "[g]reat product ideas come from the marriage of a designer's detailed understanding of a customer's need and his or her in-depth understanding of the possibilities introduced by technology" [22]. The first step of Contextual Design is Contextual Inquiry, which seeks to establish reliable knowledge

about the customers' field through interviews and team interpretation sessions, eventually forming the ground for inventing new solutions [22].

Despite their explicit focus on design process reflection, Löwgren and Stolterman presented five central activities with the first being inquiry, which "corresponds to the aspects of design work that are mainly oriented toward finding out about a design situation" [27]. Furthermore, the authors argued that the study of a present design situation, typically in a workplace, is essential for providing initial understanding of both existence and potentiality [27]. However, the potential benefit of this activity is lost if current practices are either mediated directly, thereby under-exploiting the transformative potential of technology, or if insensitive interventions break with the qualities of current practices [27].

While these (and many similar) research contributions come with nuanced, relevant modifiers for the concrete applicability of user research, the essence remains. Taken as one general perspective, it is noticeable how such influential contributions to the HCI and interaction design literature not only present early user research as pivotal, but indeed emphasize it as a sturdy foundation for innovation and thereby for design creativity.

2.4.2 Limitations of User Research. Despite this overwhelming consensus, the value of user research has been brought into question for different reasons and from various perspectives in the design and HCI literature. Some of these concerns have challenged the underlying rationale, the practical aspect, or the empirical results and derived value of user research. Norman and Verganti presented one example of this when they stated that "[e]very radical innovation he [Norman] investigated was done without design research, without careful analysis of a person's or even a society's needs" [31]. In their work, human-centered design is scrutinized for its (presumed) ability to produce innovations by studying people and discovering hidden, unmet needs based on an analysis of prior cases of inventions in society. The authors' rather bold conclusion is that design research is unlikely to produce radical product innovation through human-centered design. Radical innovations are much more likely to be driven by technology development and specific types of meaning change that avoid being trapped into existing technological and socio-cultural paradigms [31].

This perspective is also somewhat related to the longstanding discussion of the relationship between ethnography and the design of interactive systems. Randall and Rouncefield provided an overview of this discussion in the *Encyclopedia of Human-Computer Interaction* where the precarious relationship is addressed from a multitude of angles. The authors stated their own summarized view as "no strong relationship between ethnography of whatever kind and design has ever been established in the workplace or elsewhere for the simple reason that this relationship is always and everywhere contingent" [35]. What 'no strong' implies is perhaps less clear, but Plowman et al. [32] seem to share this opinion in stating that at least the majority of designers are not able to implement findings from workplace studies into the design of virtual and physical interactive systems.

These two cases present knowledge on the logical rationale and, to some degree, empirical evidence as to the generally presumed, but by some contested, intrinsic value of user research. Recently,

however, Gray et al. presented work on the experience and practicalities of design practitioners, which is relevant to the current discussion [20, 21]. Both publications provide examples of problematic situations for conducting user research, e.g., being a designer in an engineering culture such as in this example, "[i]n his work, Martin focuses on 'pure interaction design wireframes,' with no substantial user research" [21], or when design practitioners report on which methods they use, "[r]emarkably few explicit user research methods were shared" [20]. Indeed, it would seem that large companies may have less inclination toward user research, which "likely reflects not only a lack of access to users, but also a company culture that does not value this kind of access" [20]. While practical problems of conducting user research may not necessarily be a good argument against it, from an industry perspective it nevertheless contributes to the overall decision of whether to include or exclude it.

2.5 Summary

The relationship between user research and design creativity is as critical as it is complicated. Some canonical works praise the importance of a thorough understanding of users and their context, while others question the definitive importance for innovation, or even the direct link to design itself. Within the empirical work, diverging terminology hampers the synthesis of evidence across multiple disciplines, with some studies [1, 24, 45] finding positive relationships while others [5, 11, 25] find none such. If we return to the most widely accepted criteria for creativity, namely that it refers to an outcome that is perceived to be both novel and useful [37] within a given context, we may arrive at a more nuanced understanding. While results are as of yet inconclusive in terms of assessing the extent to which user research influences *novelty*, there is consensus that user research can generally increase the likelihood of developing products that are *useful* in a given context. As such, user research is likely to at the very least contribute to the latter half of the creativity equation.

3 CONCLUSION

In this paper, we have examined the assumption that user research is always valuable and relevant and that it serves as an integral part in most design processes. Our approach has been to review existing empirical evidence related to the relationship between user research and design creativity. Our study has highlighted how diverging terminology clouds the possibility to synthesize empirical evidence, and, further, how some cases (e.g. [1, 24, 45]) report positive relationships between analogous terms such as *involvement* and *innovation* or *system success*, while others (e.g. [5, 11, 25]) were not able to demonstrate such a relationship. By carrying out this preliminary review of research on the intricate relationship between user research and design creativity, we hope that the insights we have presented can serve as the foundation for and provide critical theoretical nuances to a subsequent experimental setup to further probe this prevalent topic about which much is assumed, but less is known.

REFERENCES
[1] Ulrike Abelein and Barbara Paech. 2015. Understanding the influence of user participation and involvement on system success–A systematic mapping study.

Empirical Software Engineering 20, 1 (2015), 28–81.

[2] Jesús Muñoz Alcántara, Panos Markopoulos, and Mathias Funk. 2015. Social media as ad hoc design collaboration tools. In *Proceedings of the European Conference on Cognitive Ergonomics 2015*. 1–8.

[3] Teresa M Amabile. 1982. Social psychology of creativity: A consensual assessment technique. *Journal of personality and social psychology* 43, 5 (1982), 997.

[4] Hedda Haugen Askland, Michael Ostwald, and Anthony Williams. 2010. Changing conceptualisations of creativity in design. In *Proceedings of the 1st DESIRE Network Conference on Creativity and Innovation in Design*. Desire Network, 4–11.

[5] Muneera Bano and Didar Zowghi. 2013. User involvement in software development and system success: a systematic literature review. In *Proceedings of the 17th International Conference on Evaluation and Assessment in Software Engineering*. ACM, 125–130.

[6] Anahita Baregheh, Jennifer Rowley, and Sally Sambrook. 2009. Towards a multidisciplinary definition of innovation. *Management decision* 47, 8 (2009), 1323–1339.

[7] Michael Mose Biskjaer, Jonas Frich, Lindsay MacDonald Vermeulen, Christian Remy, and Peter Dalsgaard. 2019. How Time Constraints in a Creativity Support Tool Affect the Creative Writing Experience. In *Proceedings of the 31st European Conference on Cognitive Ergonomics*. 100–107.

[8] Nathalie Bonnardel and Laurence Moscardini. 2012. Toward a situated cognition approach to design: effect of emotional context on designers' ideas. In *Proceedings of the 30th European conference on cognitive ergonomics*. 15–21.

[9] Henri Christiaans and Kees Venselaar. 2005. Creativity in design engineering and the role of knowledge: Modelling the expert. *International Journal of Technology and Design Education* 15, 3 (2005), 217–236.

[10] Henri HCM Christiaans. 2002. Creativity as a design criterion. *Communication Research Journal* 14, 1 (2002), 41–54.

[11] Peter Conradie, Lieven De Marez, and Jelle Saldien. 2017. User consultation during the fuzzy front end: evaluating student's design outcomes. *International Journal of Technology and Design Education* 27, 4 (2017), 563–575.

[12] Alan Cooper, Robert Reimann, and David Cronin. 2007. *About Face 3: The Essentials of Interaction Design* (3rd edition ed.). Wiley, Indianapolis, IN.

[13] Nigel Cross. 1997. Creativity in design: analyzing and modeling the creative leap. *Leonardo* (1997), 311–317.

[14] Janet Daley. 1982. Design creativity and the understanding of objects. *Design Studies* 3, 3 (1982), 133–137.

[15] Alan J. Dix, Janet E. Finlay, Gregory D. Abowd, Russell Beale, and Janet E. Finley. 1998. *Human-Computer Interaction* (2 edition ed.). Prentice Hall, London ; New York.

[16] Kees Dorst and Nigel Cross. 2001. Creativity in the design process: co-evolution of problem–solution. *Design studies* 22, 5 (2001), 425–437.

[17] Pelle Ehn and Morten Kyng. 1987. The collective resource approach to systems design. *Computers and democracy* (1987), 17–57.

[18] Frederica Gonçalves and Pedro Campos. 2017. Understanding and evaluating the user interface design for creative writing. In *Proceedings of the European Conference on Cognitive Ergonomics 2017*. 85–92.

[19] Frederica Gonçalves, Ana Caraban, Evangelos Karapanos, and Pedro Campos. 2017. What shall i write next? Subliminal and supraliminal priming as triggers for creative writing. In *Proceedings of the European Conference on Cognitive Ergonomics 2017*. 77–84.

[20] Colin M Gray. 2016. It's more of a mindset than a method: UX practitioners' conception of design methods. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, 4044–4055.

[21] Colin M Gray, Austin L Toombs, and Shad Gross. 2015. Flow of competence in UX design practice. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 3285–3294.

[22] Karen Holtzblatt and Sandra Jones. 1993. Contextual inquiry: A participatory technique for system design. *Participatory design: Principles and practices* (1993), 177–210.

[23] Thomas J Howard, Stephen J Culley, and Elies Dekoninck. 2008. Describing the creative design process by the integration of engineering design and cognitive psychology literature. *Design studies* 29, 2 (2008), 160–180.

[24] Sari Kujala. 2003. User involvement: a review of the benefits and challenges. *Behaviour & information technology* 22, 1 (2003), 1–16.

[25] S Kujala 1. 2008. Effective user involvement in product development by improving the analysis of user needs. *Behaviour & Information Technology* 27, 6 (2008), 457–473.

[26] Jonathan Lazar, Jinjuan Heidi Feng, and Harry Hochheiser. 2017. *Research Methods in Human-Computer Interaction, Second Edition* (2 edition ed.). Morgan Kaufmann, Cambridge, MA.

[27] Jonas Löwgren and Erik Stolterman. 2004. *Thoughtful interaction design: A design perspective on information technology*. Mit Press.

[28] Pamela D Morrison, John H Roberts, and David F Midgley. 2004. The nature of lead users and measurement of leading edge status. *Research policy* 33, 2 (2004), 351–362.

[29] Harold G Nelson and Erik Stolterman. 2003. *The design way: Intentional change in an unpredictable world: Foundations and fundamentals of design competence*. Educational Technology.

[30] ABC Nightline/IDEO. [n.d.]. *ABC Nightline The Deep Dive: One Company's Secret Weapon for Innovation*. ABC Nightline/IDEO. https://www.ideo.com/post/reimagining-the-shopping-cart

[31] Donald A Norman and Roberto Verganti. 2014. Incremental and radical innovation: Design research vs. technology and meaning change. *Design issues* 30, 1 (2014), 78–96.

[32] Lydia Plowman, Yvonne Rogers, and Magnus Ramage. 1995. What are workplace studies for?. In *Proceedings of the Fourth European Conference on Computer-Supported Cooperative Work ECSCW'95*. Springer, 309–324.

[33] Jonathan A Plucker, Ronald A Beghetto, and Gayle T Dow. 2004. Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational psychologist* 39, 2 (2004), 83–96.

[34] Jenny Preece, Yvonne Rogers, and Helen Sharp. 2015. *Interaction design: beyond human-computer interaction*. John Wiley & Sons.

[35] Dave Randall and Mark Rouncefield. [n.d.]. The Encyclopedia of Human-Computer Interaction, 31. Ethnography. ([n. d.]).

[36] Yvonne Rogers, Jenny Preece, and Helen Sharp. 2011. *Interaction design*. Wiley, Hoboken, N.J.; Chichester.

[37] Mark A Runco and Garrett J Jaeger. 2012. The standard definition of creativity. *Creativity Research Journal* 24, 1 (2012), 92–96.

[38] Donald A Schön. 1983. The reflective practitionerhow professionals think in action. (1983).

[39] Brian Shaw. 1985. The role of the interaction between the user and the manufacturer in medical equipment innovation. *R&D Management* 15, 4 (1985), 283–292.

[40] David Sheff. 1985. Playboy Magazine, Interview: Steve Jobs. http://reprints.longform.org/playboy-interview-steve-jobs

[41] Ben Shneiderman, Catherine Plaisant, Maxine Cohen, and Steven Jacobs. 2009. *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (5 edition ed.). Pearson, Boston.

[42] Herbert A Simon. 1973. The structure of ill structured problems. *Artificial intelligence* 4, 3-4 (1973), 181–201.

[43] Steve Jobs (uploaded by Christopher Zobrist). 2013. Steve Jobs on Market Research. https://youtu.be/2U3w5Blv0Lg?t=48.

[44] Glen L Urban and Eric Von Hippel. 1988. Lead user analyses for the development of new industrial products. *Management science* 34, 5 (1988).

[45] Eric Von Hippel. 1986. Lead users: a source of novel product concepts. *Management science* 32, 7 (1986), 791–805.

[46] Eric Von Hippel. 2005. *Democratizing innovation*. MIT press.