Tracing Links between UX Frameworks and Design Practices: Dual Carriageway

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ABSTRACT

With the main goal to understand how User Experience (UX) theoretical frameworks inform design practices and vice versa, we adopted both top-down (theory-driven) and bottom-up (practice-driven) approach. We applied two popular UX frameworks – Hassenzahl's hedonic-pragmatic model and McCarthy & Wright's sense-making experience - to scope the search for candidate "Strong Concepts" (SC), one form of intermediate-level knowledge, which might contribute to the realization of our overall goal. However, due to the problem of 'fading traceability', which arguably reflects the quintessential nature of theory-assimilated design, the number of SC candidates identified is limited. Based on the reviews of some design-research experts on those candidates, *Randomness* is identified as a promising SC. Some design cases appropriating Randomness are presented. The challenges experienced in the SC identification process have stimulated further discussions on the tenacious issues between theory and practice.

Author Keywords

UX frameworks; Randomness; Fading traceability

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

How do theoretical frameworks inform practical works, or vice versa? As the field of User Experience (UX) is maturing, it seems more likely to identify plausible answers to this tricky question now than about 15 years ago when UX was still at its infancy. In the broadest sense, UX is

defined as an extension of usability to focus on people's feelings arising from using interactive systems. The range of UX frameworks developed since late-1990s has been rather wide (e.g., [6], [8], [14], [16], [29], [31], [41]). While each UX framework has its specific emphasis such as visual aesthetics [21] and temporality [16], they share basic constructs such as interaction design and experiential quality. However, in this paper, we do *not* aim to evaluate UX frameworks.

Instead, our overarching research goal is to *understand how abstract UX frameworks can inform concrete design and evaluation work in academic as well as industrial projects.* It reflects the age-old question about the gap between theory and practice and how to bridge them. The recurrence of such a gap-bridging research inquiry suggests its high significance on the one hand and high formidability on the other hand. It is deemed a daunting task, because the breadth and depth of critical reviews it implies is immense. To render the task more manageable while still enabling meaningful insights to be gained, we leverage the recent intriguing work published by Höök and Löwgren [13] (henceforth: H&L), which aims to enhance design knowledge production by synthesizing practices (or 'instances' in their terms) and grounding them in theories. In fact, the coincidentally shared goal between their and our research work can be seen as a response to the recent discussions on the imbalance between the empirical and theoretical work in UX with the latter being regarded as under-researched [20].

Before delving into the arguments of H&L, we lay the groundwork of this paper by defining the key idea – *framework*. To avoid introducing yet another definition to the HCI community, we have reviewed existing attempts (e.g. [28]) and agreed that the one recently proposed by Stuart Reeves [33] resonates with our understanding the most. It is read as: "*a way of packaging up HCI theory into disseminable and reusable parcels in order to inform subsequent design and application.*"

H&L propose that the space (or gap) between abstract design theories and concrete instances can be populated by

different forms of *intermediate-level knowledge* (Figure 1; see also [27]). Such knowledge can be divided into two major types – generative and evaluative. Examples of the former include patterns, guidelines, annotated portfolios, and *strong concepts* (**SCs**) whereas those of the latter include experiential qualities, heuristics and criticism.
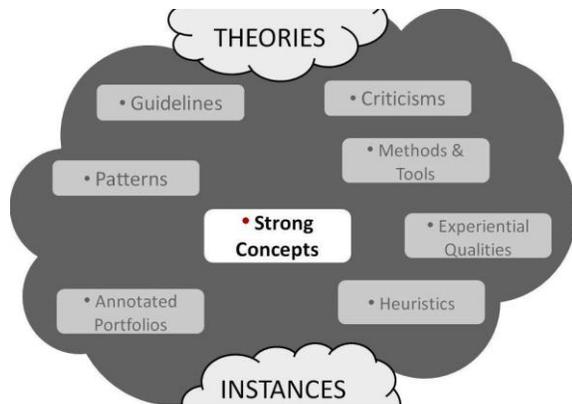
Figure 1. Intermediate-level knowledge (adapted from [13])

H&L elaborate on the notion of SC with three examples of different maturity - Social navigation, Seamfulness, and Trajectory. They then proceed to describe how SCs, as design elements, are abstracted from particular instances. Specifically, designers and researchers can enrich their repertoire by appropriating such instances and applying their new knowledge to create new instances. H&L define four basic characteristics of SC and provide guidelines for constructing a SC in terms of meeting academic criteria (contestable, defensible and substantive), vertical grounding (to be rooted in a number of instances) and horizontal grounding (to be linked to or differentiated from similar ideas).

As H&L seem offering plausible solutions to the research question how UX frameworks inform practical works, we have been motivated to review their proposal in two ways. First we reviewed the process H&L adopted for identifying SCs, commenting on its openness and contrasting it with similar endeavors [5] [12]. Second, we extracted ourselves alternative SCs, using the approach described in H&L, from the literature scoped by two popular UX frameworks: Hassenzahl's [11] and McCarthy & Wright's [29].

REVIEW ON STRONG CONCEPTS
In this section, we review the notion of Strong Concepts with regard to three issues: openness, bottom-up approach, and learning from examples.

Openness
While SC appears to be an attractive notion, given its dual properties of being abstract and concrete, its generativity (i.e. its purported main impact) in terms of enabling the creation of new instances could be hard to demonstrate. For instance, in the description of Social Navigation, the relatively mature SC, some instances from the literature traced back to late 1990s and some more contemporary are

analysed. While the analysis is intriguing, it seems primarily *explanative* rather than *generative* (let alone *predictive*, which is not in the remit of H&L's work; cf. Shneiderman's [39] arguments for the tripartite role of theories). Also, H&L summarize the options of realizing this particular SC. Eventually it is entirely at the discretion of a designer-researcher to interpret and adapt the SC to create new instances for new application contexts. Such openness and malleability to interpret and appropriate a SC renders it extremely challenging to scope and validate it.

Inclusion (or exclusion) of certain instances that can contribute to strengthening a SC seems arbitrary unless the distinguishing characteristics for a SC would be transitive for its subsuming instances (cf. the inheritance property in object-oriented programming). However, this condition is not explicitly specified in H&L's paper, although logically speaking one can and should assume so. Another ambiguity to be resolved is the genesis of a SC. H&L propose that a single or multiple instances, which may address specific use cases or may also be largely explorative, can be the source of a SC. With this initial but critical step being wide open, one may wonder where the journey of literature search to identify relevant instances should start off, given the enormous (if not borderless) body of publications (not only from HCI but also from other fields).

Bottom-up approach
Two research endeavors similar to H&L's work on SC, while adopting different approaches, have recently been undertaken. [12] was published around the same time as the work on SC and [5] was after that. Specifically, [12] adopted what we call the *artifact-based* approach, identifying design artifacts from the literature pertaining to mediation of intimate relationships with the aim to extract design strategies. In contrast to the assumption that design cases (or "instances" as H&L refer to) can be abstracted to SCs, which may further be distilled into some higher-level frameworks or theories, [12] do not ascribe this inductive property to design artifacts. Instead, [12] assert that the design knowledge underpinning the artifacts should be derived from existing theoretical work, leading to 'theoretically-inspired design' (p. 14). Arguing along this line, SCs should be developed from theories rather than from instances (i.e., top-down rather than bottom-up) and intermediate-level knowledge should serve as bridges between theory and practice.

These views resonate with the notion of Bridging Concepts [5], which, as acknowledged by its proposer, is akin to SCs but with a different emphasis. Accordingly, the term is underpinned by the intent to bridge the gap between general theories and particular design cases. Nonetheless, [5] point out that they do not argue whether operationalizing theories through concepts (top-down) is inherently better than abstracting concepts from practice (bottom-up) as a means for generating intermediate-level knowledge. They further claim that bridging concepts can be inspired by design

cases (or 'exemplars' in their words) as well as theories. Nonetheless, [4] uses the theory-driven, top-down approach to derive two bridging concepts from pragmatism. As argued by [5], such theoretically grounded development of a bridging concept aligns with Stolterman and Wiberg's [40] 'conceptual constructs', which can be seen as a top-down approach with the ultimate goal of advancing theories rather than informing design practice.

Learning from examples
H&L mention that "*… the approach advocated by Zimmerman et al [2007] really is not much different from the tradition in design education of studying canonical examples*". According to Zimmerman et al (cited in H&L), it is *research artefacts* created by interaction designers with different resources (e.g., theories, models, data) that link HCI research to practice. We interpret that H&L tend to distinguish their approach by arguing that the (social-cognitive) process of teasing out a SC from design instances, which can be seen as research artefacts, is more valuable knowledge than SC per se. In other words, SC may mainly serve as a transient platform to stimulate a designer-researcher to reflect, abstract and appropriate instances.

As the theme of this paper implies, it is necessary to strengthen theoretical justifications why design instances and the SC so induced are effective forms of knowledge for designer-researcher, we propose referring to the well-researched topics such as 'learning from examples' [34] in the domain of educational psychology to shed more light onto this issue. Accordingly, a highly efficient way of learning is borrowing knowledge evolved over years of others' experience and reorganizing it to fit one's existing knowledge and to use it to serve one's specific goal. Example-based learning is demonstrated to be effective, especially for novice learners [42], not only for structured cognitive tasks in domains such as mathematics and physics, but also for 'ill-defined problems' such as recognizing designer styles [35] and reasoning about legal cases [30]. The theoretical assumption underlying these phenomena is that worked examples enable learners to dedicate their cognitive capacity to study the worked-out solution procedure (cf. design installation [4] in our case), thereby building up a cognitive schema that can be adapted for addressing other goals. While example-based learning is apt for a range of domains, several factors influence its effectiveness, including who uses the example, how the example is constructed and delivered [42]. Furthermore, it can be inspirational to see how instructional designers to translate cognitive or learning theories into practical classroom activities (e.g. lesson plans).

SELECTION OF UX FRAMEWORKS
To facilitate the identification of SCs and, more important, to substantiate the links between frameworks, SC and instances, we propose putting frameworks in the forefront, using them to steer the search for relevant instances (Figure 2). This approach has the advantage of firming the

theoretical ground. This top-down strategy for constructing a SC can complement well the bottom-up counterpart described in H&L's paper. This is also consistent with the above analysis regarding the preference of the top-down to bottom-up approach.
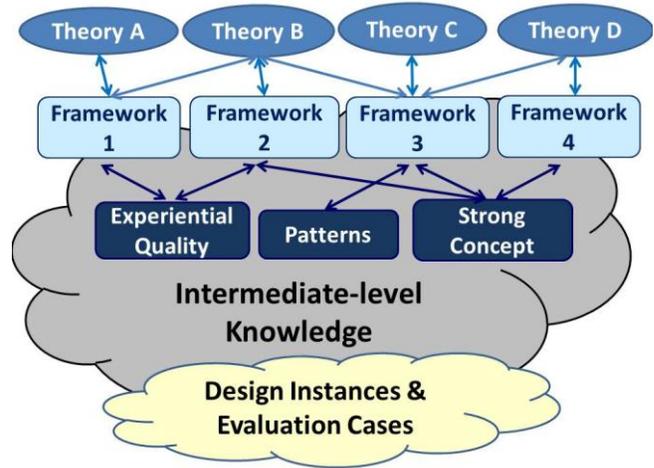
Figure 2. Relations between theories, frameworks, intermediate-level knowledge, and practical work; the linking role of frameworks and bi-directional connections are explicit.

To substantiate the value of SC, we argue that it is necessary not only to identify the source in terms of one or more promising instances (i.e. we coin them 'anchor instances') to build up a candidate SC, but also to demonstrate how the SC so constructed can be applied in a new context. While H&L already point out that the research process described is interpretive rather than deductive (p.14), the practical value of a SC would be further enhanced if illustrative cases could be provided.

To structure the aforementioned analysis work, we propose using templates to capture the process. It might be against H&L's principle of openness (cf. standardization and rationalization in the case of patterns is what they explicitly object to) which, however, may be prone to confusion and misinterpretation. In particular, the process of abstraction from instances to SC, which relies heavily on expert knowledge (cf. "… deep familiarity with the original instances and their properties", p.15), should be explicitly documented to enable others to learn from it, thereby enhancing the replicability of the research process and stimulating dialogues on the related challenges and insights.

As mentioned earlier, a number of UX frameworks have been proposed in last 15 years. As analysing how each of them informs practice would be a prohibitively resourceful task, we have applied the following steps:

Step 1: We identify key references of the UX frameworks about which we are knowledgeable. Then we discuss their abstractness and comprehensiveness. If a framework addresses only a specific experiential quality such as flow [36] or visual aesthetics [21], it is excluded from being a

candidate framework for scoping the subsequent literature search (see below) (NB: this inclusion/exclusion strategy has no implication about the value of the related work).

Step 2: Eight candidate frameworks are short-listed (Table 1). For each of them, we compose a search phrase constituted by its author name and key concepts. Then we enter the phrase into the free-text search box of the ACM Digital Library, which has an extensive coverage of HCI literature, to get the number of hits. These phrases instead of the corresponding publication titles are used in order to improve the search results.

Step 3: We select the two frameworks with the highest number of hits, which apparently is only a rough estimation of their being applied in practice.

UX Frameworks (search phrases in ACM DL)	NH *	Key Ref.
Hassenzahl hedonic pragmatic model	214	[11]
McCarthy Wright sense-making experience	98	[29]
Norman emotional design visceral reflective behavioural	70	[31]
Forlizzi Battarbee experience co-experience	53	[8]
Desmet Hekkert aesthetic emotional meaning experience	41	[6]
Thüring Mahlke components user experience	24	[41]
Karapanos temporality experience	21	[16]
Jordan physio psycho social ideo pleasures	15	[14]

* NH=Number of hits returned as of October 2014

Table 1. Candidate UX frameworks for scoping the literature search for strong concepts

Two caveats are mentioned to avoid any misinterpretations: (i) There is no intention to claim any statistical validity of the numbers shown in Table 1; (ii) This is *not* the goal of this paper to evaluate the scientific value of the UX frameworks identified, which are primarily used to scope the search for strong concepts.

According to Hassenzahl's hedonic-pragmatic framework [11], when individuals encounter a product, they perceive its features and thereby construct a preliminary personal evaluation of the product quality comprising sets of pragmatic and hedonic attributes. Different consequences are resulted from this initial perceived product quality: cognitive consequences in terms of judging the product appeal (e.g., goodness), emotional consequences (e.g., pleasure, satisfaction), and behavioural consequences (e.g., continued use). However, such consequences of a specific product quality tend to vary with the particularities of the usage situation.

McCarthy and Wright's sense-making of experience framework is integrated with the four threads of experience ([29]). The *sensual* is concerned with our bodily engagement with a situation, characterized as visceral experience. The *emotional* involves ascribing importance to other objects with respect to a person's (or her social others') needs and desires. The *spatio-temporal* refers to the

time and place where an experience is located. The *compositional* is concerned with the narrative structure of an experience. The six processes of sense-making – *Anticipating, Connecting, Interpreting, Reflecting, and Appropriating* - which are not linear or causal in relation, contribute to holistic 'felt experience'.

While the limited space does not allow us to elaborate the two frameworks, it is relevant to point out that they have different theoretical roots. Hassenzahl's is primarily rooted in motivational psychology whereas McCarthy & Wright's is rooted in pragmatism of Dewey and Bakhtin.

IDENTIFICATION OF STRONG CONCEPT CANDIDATES

Using the two UX frameworks to scope the literature search was meant to sharpen our focus and facilitate identification of SC candidates. Nonetheless, this task proved challenging, primarily due to the critical issue we coin as **fading traceability**. It denotes the situation that authors cite the framework in the front sections of their paper, claiming that their work is based on it, but when coming to the description of the actual design or evaluation work the framework is no longer referenced.

Source (title, author)
Candidate strong concept (proposed name)
Referenced framework: [ ] Hassenzahl [ ] McCarthy & Wright [ ] Other
Discovery journey (how the source is identified)
Extent of use (check boxes for the sections of the paper where the framework is described: [ ] Bibliography [ ] Introduction/Background/Related Work [ ] Method (Procedure & Results) [ ] Discussion [ ] Conclusion/Future Work
Direct role of SC (in the new design as described in the paper) [ ] Yes   [ ] Somewhat   [ ] No (followed by justification)
Four criteria for SC inclusion (how well they are met: dynamic gestalt, use practice, core idea cutting across use situations, abstraction ([x], pp.5-6))
Scoping (other types of intermediate-level knowledge related to SC)
Grounding ([x], p.12) *vertical*: other design instances contribute to the SC proposed; *horizontal*: other concepts similar to the SC and their major differences
General theories (which the SC illustrates or concretizes)
Three academic quality criteria (*contestable, defensible, substantive* [x], pp.10-11; extent of meeting them)
Appropriation of SC (for the design of an artifact in a specific context)

Table 2. Template for identification of Strong Concepts

Specifically, an article is included if its authors explicitly describe how they use the framework for designing artefacts. However, an article is excluded if its authors only cite the framework as "related work" but do not employ the framework for guiding their practical work at all. We applied this key criterion to the first 50 hits (which are

sorted in relevance) for Hassenzahl's and the same for McCarthy & Wright's (cf. Table 1). We also created a template to structure the analysis (Table 2), which is essentially derived from H&L.

SC Candidate: Randomness
Finding papers that address all of the items of the template proved very difficult. We could identify only a handful of SC candidates, which were evaluated by some known design-research experts as well as anonymous reviewers of the earlier version of this paper. Eventually, only one SC candidate - *Randomness* – is regarded as promising. The others are eliminated primarily due to the lack of design cases to substantiate the grounding (Table 2).

In the ensuing text, we first present 'anchor design instances' from which the SC Randomness has been induced. Then we explore the two other levels linked to intermediate-level knowledge (Figure 2): At the higher 'Theories' level, we study the philosophical backdrop specific to Randomness rather than the theoretical roots of the two UX frameworks (see [11] [29]); At the lower 'Instance' level, we study other design cases by analysing how they appropriate Randomness.

Anchor design instances of Randomness
The identification of the SC Randomness can be linked to four 'anchor' publications ([22], [23], [24], [25]), which refer to the two selected UX frameworks ([11], [29]), though at the different phases of the design lifecycle, and have inspired other design cases. The first [25] on "serendipity shuffle" presents a qualitative analysis of shuffle listening where the four threads of experience are used as a lens to analyse the data. The second [23] discusses how randomness can be used as an innovative design resource for supporting rich and novel user experiences. The authors borrow the mechanism of music shuffling and attempt to understand the experiential outcomes in order to ground the notion of Randomness. They discuss existing systems that are designed with randomness in mind (e.g., random blogs), and thus suggest some broad categories of systems that randomness may be applied, including digital libraries [22] and reminiscence technologies such as digital photos [24]).

Leong and his colleagues [22] [24]) assert that encounters with serendipity are more likely to arise when the random selection is unconstrained (i.e., when the shuffle algorithm picks tracks randomly and freely from people's entire music or photo library instead of being constrained to only subsets of the library). The random presentation of objects (e.g., photos, songs) can engage or intrigue people by heightening their attention and drawing them more deeply into the objects. The unpredictability adds a sense of excitement, a bit of edge, and enjoyable experience. Abdicating choice to a system such as shuffle listening becomes a very significant feature when engaging with a device that holds a large amount of digital media.

The authors use Hassenzahl's model of experiential qualities (i.e., stimulation, identification, evocation) as behavioral outcomes that Randomness can support. While the notion of shuffling is an established interaction design technique, the study of its psychological outcomes is somewhat novel to the design research community; this SC is contestable. It is also defensible because it is empirically and analytically well-grounded in the UX frameworks. Substantive is it as well, given different design cases drawn on the idea of Randomness (see below).

Philosophical backdrop on Randomness
Randomness can be defined as an occurrence having no definite aim or guidance in a particular direction and without any method or conscious choice (adapted from the Oxford English Dictionary on 'random'). The notion of randomness has been entertained by various scholars. Of particular prominence is Gregory Bateson's philosophical stance on the role of dual stochastic processes (i.e., genetic change and somatic change) in human lives [1]. In both processes a large number of alternatives can be randomly generated, which are then somehow reduced to a smaller set by a non-random selection process. Bateson [1] argues that not only the biological but also cognitive processes are dual stochastic. A number of creative ideas can randomly be triggered and then assimilated into a pre-existing system of beliefs in order to sustain its consistency and integrity, which is a non-random process of reinforcement [37].

In modern art, stochastic paintings [43] are considered as a particular form of aestheticism, because of their unpredictability and diversity. Randomness can be exploited to inspire creativity [7], trigger spontaneity, deliver uniqueness, contribute to aesthetic quality, and enable open-ended processes critical for discovery-oriented design [18]. Leong and his colleagues [22, 23, 24, 25] have applied methods of randomness in interaction design to elicit new user experience, based on the assumption that randomness can lead to fun, surprise, delight, and, above all, enjoyable serendipity to users (cf., the notion of *technology-mediated serendipity* [23]).

Other design cases on Randomness
A more recent example of exploiting randomness is self-morphing randomness [18], which is described as a design method where people can morph a product by adapting its core functionality to create a unique style of the product. This resonates with the emerging DIY culture in the field of HCI. [18] appropriate the notion of Randomness in their three design cases - Light-morph-Light, Light-print-Light, and Sound-morph-Sound.

[15], in evaluating their mixed-reality game, observed that how serendipitous connections between the physical and digital worlds were embraced by their study participants for organizing their runs in a city with the use of a narrative-based apps. [15] compared the desirable quality of serendipitous experiences when engaging in their game

with Leong et al's [22] meaning making when listening to randomly shuffled music.

[17], based on their study on post-crossing, argue for the positive effect of randomness in design and discuss questions on the awareness and expectancy of random events. As arrival of a postcard is serendipitous and comes as a surprise, designers might harness this idea by integrating unpredictability into communication systems, which could then induce feelings of anticipation and greater enjoyment around the receiving and sending of digital messages.

An intriguing implication addressed in Leong et al's [22] is to harness randomness in the design of an *unfinalized* device, because such incompleteness can encourage people to see technology as ever-evolving and becoming. Built upon this presumption that randomness is a means to create a "blank" that induces and guides the user's constructive activity, Seok et al [38] explore the design space of non-finito products through three design cases – poke feature of Facebook, status message of a social mobile chat app, and a wireless sensor block for environmental information.

[26] argues that one part of the serendipitous experience involves generating unexpectedness which creates digital accidents or unexpected information, and the other part involves making meaning in the context of everyday life, which indicates judicious discoveries or an intellectual advancement. The usual approach in attempting to create the effect of unexpectedness is to employ randomness, which is however not an experiential quality per se. Liang [26] demonstrates with three design cases - Social Clock, Social Radio and Sound Capsule - that computer-generated randomness and improvisational activities by social actors are also possible means for providing unexpectedness.

[19] points out that the focus of [22]'s investigation was squarely on the user and the user experience rather than on the use of randomness to generate product ideas. He then posits that randomness can be used as a strategy to put heterogeneous people in a team to design an artefact and also as part of exploratory design process. The team can begin by mapping the issues concerning the concept of work using non-hierarchical mind mapping and start with the main core themes of who, what, where, when, why and how. The team members, either as individuals or as groups, would subsequently be encouraged collectively to develop list of topics that should be randomised. [19] posits that the leapfrog effect forces unexpected and random ideas and concepts, thereby offering opportunities for developing creative insights within both designers and/or non-designers in the new product development process.

GENERAL DISCUSSION
Our discovery journeys for identifying SCs, which are not elaborated in the preceding text due to the limited space, consistently point to two major challenges: *fading traceability* and *process malleability*. The former has been

discussed above whilst the latter corroborates our review on the genesis of a SC; the related identification process, as it is described in H&L, is (too) open to interpretation. Both challenges render the critical task of literature search daunting, especially looking for design instances to ground a SC. It is hard to find 'evidence' to show the *organic* link between a SC and instances (NB: design instances can substantiate a SC which in turn inspires other instances). While the bibliography of the paper from which a SC is derived and the 'cited by' function in ACM Digital Library could help, the search for such instances is hampered by fading traceability. Due to this grounding issue, we have eliminated some SC candidates but conscientiously argued for Randomness as a SC.

The challenge of traceability suggests that there could be a different conception of theory use in practice. For instance, a framework could be used as a springboard to launch a design idea and the subsequent process might only be loosely linked to or even completely detached from the 'base' framework. However, it is arguable that theoretical frameworks internalized as interaction design *bricolage* can be applied without a designer being conscious of their enactment in the design process. Externalizing sources of inspiration on an ongoing basis in the form of textual (or audio-/video-) annotations (cf. 'annotated portfolios' [27]) can help the originating designer and others to reflect on the relationship between designerly behaviours and theoretical frameworks. However, such externalization may undesirably modify the actual practice, making it no longer natural as it would have been.

In fact, the authors of the "Other design cases on Randomness" described above make no explicit references to any theoretical framework apart from adopting Leong et al's [22] [24] views on randomness. Intriguingly, [12] found that only 44 out of the 92 publications reviewed were making some references to existing theoretical or empirical knowledge, suggesting that the corresponding design artifacts were developed primarily based on the design researchers' own views. The prevalence of such approach and attitude of "building a chariot behind closed doors" needs to be verified, given the possibility of internalized theoretical insights that are tacit and untraceable.

As triggered by the issue of fading traceability, a reviewer of the earlier version of this paper has posed several thought-provoking questions:

Q1. *Is the academic literature an appropriate representation of the body of design knowledge consisting of design instances?*

Q2. *How does a systematic and literature-based process relate to the expert judgment of an experienced designer?*

Q3. *Is it possible that a designer's genre expertise is related to the construct of UX frameworks, or do they rather represent orthogonal dimensions?*

Q4. What is the purpose of articulating intermediate-level knowledge in the context of scholarly knowledge production and in the context of design practice?

Q5. Is there a role for design expertise in the traditional sense within academic research, and if so, how is that role related to the articulation of intermediate-level knowledge?

These five questions are somewhat interrelated. *Q1* and *Q2* challenge a fundamental assumption on the relevance of academic literature for reflecting actual design practices. However, the work of H&L, [12] and [5] on SCs, design strategies and bridging concepts are predominately (if not entirely) based on academic articles. Referencing peer-reviewed literature, which has undergone quality control, albeit with different stringency, is requisite for formal publications that are typically used as a yardstick for an academic's performance. This deeply entrenched value in the research community seems resistant to change. On the other hand, the design community has alternative approaches to documenting artefact production such as annotated portfolios [8] [27] which seem not as disseminable as conventional publication channels. However, formalizing such documentation and dissemination processes might hamper creativity on which the design work draws. The tension between design and research, as discussed in [8], is hard to ease.

Q3 and *Q5* relate to the persistent gap between design and research work, despite the increasing effort within the recent decade to bridge it through the advocacy of *research-through-design*. Don Norman, in his recent keynote in NordiCHI 2014, asserted that design is craft education with limited theories which are nevertheless much needed, especially on aesthetics, delight, and fun. This corroborates with the observations in [12] that designers tend to rely on their practitioner wisdom. Also Norman claimed that HCI professionals know theoretical principles but not design. This reflects the current situation in the field when more and more HCI research groups shift emphasis from evaluation to design in order to swim with the tide, though a nontrivial number of HCI researchers essentially have no formal training on design.

Q4 is actually the main thrust of this paper. In the context of scholarly knowledge, a SC can refine the theoretical frameworks from which it is derived through systematic analyses of their fit. For instance, while [11] and [29] can provide the theoretical lens for developing a deep understanding of the work built upon Randomness, it is also insightful to study Bateson's views [1], which may somehow enrich the two UX frameworks. In the context of design practice, SC is informed by old design instances and in turn informs new ones resonates with the notion of 'design precedent', which denotes a prior design solution that can be partially or wholly adopted for a new design situation [32]. The concept of design precedent has been applied in design education to shape designerly thinking

(e.g., [32]) and in education design to reinforce the established approach of instructional design (e.g., [10]; cf. example-based learning discussed above). Insights from both endeavors can extend the notion of SC, especially how it stimulates new designs. To realize the potential value of SC for building and consolidating theories in UX, it is necessary to make documentation of concrete examples more commonplace; a practice needs strongly encouraged.

The challenge of process malleability involves the issue on levels of abstraction. Between a concrete artefact and a fully abstracted general theory there could be a range of abstraction level [27]. How abstract a SC should be to optimize its generalizability across contexts is a tricky question. As portrayed in Figure 1 and described in H&L, all types of intermediate-level knowledge seem at the same abstraction level, but they can arguably be in some form of hierarchical relationship, e.g., a design pattern can subsume a set of experiential quality [27]. How these knowledge types are interlinked need to be further researched.

This paper has two limitations: i) The number of UX frameworks investigated was restricted to two; ii) The database used was only ACM Digital Library. We started with a very ambitious goal of understanding how UX frameworks inform actual design and evaluation work. The number of UX frameworks identified (i.e., 23 with various breadths and depths, albeit not yet exhaustive) implies immense research resources. It is sensible to scope the study to a more manageable and still meaningful scale in order to gain some useful insights. With this initial but significant groundwork, we can map out our future work.

CONCLUSION AND FUTURE WORK

We identify Randomness as a SC, using the research protocol described in [13]. As the notion of SC is emerging, there is room to improve, especially its fuzziness. This is well captured by Benford's [2] response to his notion 'trajectories' being identified as a SC candidate in H&L, "*it feels like the [strong] concepts need an appropriate level of generality, being structured enough that you can repeatedly attack a design from different perspectives, and yet not so prescriptive that they close down creative thinking.*"

For our future work, we will identify strategies to address the limitations by including more relevant UX frameworks and databases and consequently more concrete cases. We will further explore the intricate relations between UX theories and frameworks, and their links to both concrete design instances and *evaluation* cases. While evaluation is not the focus of H&L, we regard it as relevant to analyse evaluation cases and experiential qualities.

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