

A Framework for the Experience of Meaning in Human-Computer Interaction

Elisa D. Mekler
Faculty of Psychology
University of Basel, Switzerland
elisa.mekler@unibas.ch

Kasper Hornbæk
Department of Computer Science
University of Copenhagen, Denmark
kash@diku.dk

ABSTRACT

The view of quality in human-computer interaction continuously develops, having in past decades included consistency, transparency, usability, and positive emotions. Recently, meaning is receiving increased interest in the user experience literature and in industry, referring to the end, purpose or significance of interaction with computers. However, the notion of meaning remains elusive and a bewildering number of senses are in use. We present a framework of meaning in interaction, based on a synthesis of psychological meaning research. The framework outlines five distinct senses of the experience of meaning: connectedness, purpose, coherence, resonance, and significance. We illustrate the usefulness of the framework by analyzing a selection of recent papers at the CHI conference and by raising a series of open research questions about the interplay of meaning, user experience, reflection, and well-being.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**;

KEYWORDS

Meaning, meaningfulness, meaningful interaction, meaning-making, user experience

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1 INTRODUCTION

What makes interaction good? The answers to this question are steadily evolving in human-computer interaction (HCI) [20, 28, 52], having in the past included consistency, transparency, usability, and positive emotions [42]. Recently, *meaning* has received increasing interest as a quality of interaction. There have been explicit calls to design moments of meaning [16, 36, 41], to foster enduring meaningful user experiences over momentary pleasure [84], and to consider how technology use impacts the human experience of meaning and meaninglessness [58, 72]. Some researchers even argue that computers struggle to support and might easily undermine meaning [69, 70]. The emerging interest in meaning is also shared by the tech industry. Zuckerberg, for instance, declared in January 2018 that Facebook aims to prioritize 'meaningful interactions' [73, 123].

However, while notions of 'meaning' have long been central to work on embodied interaction [14, 26, 39] and semiotics in HCI [21], meaning as a quality of interaction remains elusive. As we will later show, the notions of 'meaning', 'meaning-making' and 'meaningful' interaction are prevalent and appear to be valued in HCI. Yet their components and definitions are rarely explored; Kaptelinin [58] recently noted, for instance, that "there has been relatively little attention to systematic conceptual analysis of meaning making per se" (p. 10). As a consequence, it is difficult to design for, assess, evaluate or simply discuss meaning as a quality of good interaction. While many areas in HCI concern contexts of use that clearly go beyond mere task efficiency or momentary joy—say, reflection [10, 111], designing for the self [122], or life disruption [81]—most UX studies focus on usability and positive affect [3, 95]. This is all the more unfortunate, as psychology provides ample evidence that the experience of meaning is key to people's well-being [38, 55, 74, 102, 110].

We present a framework that outlines the components of meaning as an experience in interaction: connectedness, purpose, coherence, resonance, and significance. These components are oriented toward the self/the world, motivation, understanding, feeling/intuition, and evaluation. They are based on a synthesis of psychological research on meaning in life, meaning-making, and meaning maintenance. Our aim is to improve conceptual clarity about meaning in HCI and

to complement current models of user experience; the framework can also be used to support evaluation and design. We illustrate the usefulness of the framework by analyzing a selection of CHI papers and show how previous HCI research has – and hasn't yet – addressed meaning in interaction, identifying open research questions about the interplay of meaning, reflection, user experience, and well-being.

2 RELATED WORK

The view of what makes up quality or goodness in interaction—"what makes interaction good"—is an important question in human-computer interaction (HCI). Answers to this question serve to advance theory in HCI and may ultimately influence measures, methodology, and design [52]. Following Cockton [19], we assume that quality in use and fit to context are qualities of user experience during interaction, but also that "the determinants of interaction quality [...] lie in the lasting value of enduring outcomes. We should judge systems by what endures beyond interaction" (p. 133). Thus both experience *during* interaction as well as outcomes that endure *beyond* the moment-to-moment interaction are valid answers to the question about goodness. Similar to most work on user experience [e.g., 42], we assign primary importance to users' experience and perception of both interaction processes and interaction outcomes. Next, we turn to how meaning might qualify as a quality of interaction and to earlier work on meaning, both in HCI and in psychology.

Meaning as a Quality of Interaction

Meaning is a complicated word; fleshing out our understanding of it in relation to HCI is the main purpose of this paper. But to avoid misunderstandings, we outline a few distinctions that are key to understanding meaning as a quality of interaction. Meaning is typically used akin to a form of fulfillment [69], worth [19], or 'goodness' [28] of interaction. This is similar to the use in "a meaningful experience", "finding meaning in an activity", or "to be engaged in meaning-making". Thereby, meaning may be applied to objects, experiences, activities, and behavior. Alternatively, meaning may be used as a non-modifying term to indicate a general sense of purpose, significance, or coherence. This is different to other uses of meaning, in particular that of a reference or intended expression (e.g., "meaning a particular type of user", "the meaning of a word"). In particular, semiotics in HCI focuses on this last sense of meaning [21].

Given this understanding, recent work has in different ways proposed meaning as a focus for HCI. Fallman [28, p. 1053] argued that within HCI research "third wave approaches tend to share an interest in meaning and in human experiences, momentary or long-term, of using or living with a digital product or service, often termed the 'user experience'." How has this interest in meaning been realized?

User experience research has provided a set of answers. Hassenzahl et al. [41] called for design to focus on affording moments of meaning, and argued that meaning stems from the extent a product satisfies various psychological needs. However, this call is not backed up by any empirical data. While their original 2010 study included the psychological need for meaning [40], it is absent from their discussion of pleasant and meaningful user experiences [41], which largely draws upon the results of the aforementioned study. Studies examining positive user experiences [40, 93, 112] found meaning (operationalized as self-actualization [106]) to be consistently the least salient need. Hassenzahl et al. [40] therefore concluded that it is difficult to imagine situations in which interactive technologies afford experiences of meaning. In contrast, Mekler and Hornbæk found that this depends on users' motivation [84]. Eudaimonically motivated (i.e., striving to pursue personal ideals) and social experiences were considered more meaningful than hedonic experiences, which pertained to relaxation and short-term pleasure. Relatedly, Lukoff et al. found that users consider habitual smartphone interactions to be among the most *meaningless* [72].

Some work has looked into the design qualities that afford the experience of meaning. Grosse-Hering et al., for instance, incorporate slow design for users to spend "more time for those parts of the interaction that are meaningful" [36, p. 3431]. Carpenter and Overholt [16] discuss identity, enabling stories, and designing for subtlety, as design linkages that allow for meaningful experiences with a pregnancy wearable. Finally, Lu and Roto focus on meaningful experiences in the workplace as an experience goal [71]. Based on the mechanisms of meaning at work outlined by Rosso et al. [100], Lu and Roto analyzed a series of work tool design cases and found them most suitable for supporting employee's self-esteem and self-efficacy, but less likely to facilitate a sense of authenticity of purpose.

Other work has focused on meaning in life more globally. Light et al. [70, p. 728], for instance, called for "suggestions for qualities we can employ in our design work that speak to the existential crisis we find ourselves facing. These suggestions might encourage tools that focus on meaning, purpose and fulfillment in difficult, unstable and rapidly changing times". Kaptelinin [58] focused on existential concerns—mortality, identity, isolation, freedom and meaning—and their relation to both psychological research [e.g., 97, 121] as well as to HCI. However, as quoted in the introduction, Kaptelinin was concerned about the lack of theory building around meaning-making. While he stresses the importance for HCI to consider existential concerns, he writes relatively little about what the human experience of meaning – or the absence thereof – implies for technology use and HCI; nor does he provide a definition of meaning.

In some theories, meaning forms an ontological basis for any discussion of interaction; this is prominently the case for work on embodied interaction [14, 26, 39]. Harrison and colleagues [39] discussed how the role of meaning evolved throughout different research paradigms in HCI: "The first paradigm [...] ignor(es meaning) unless it causes a problem, while the second interprets meaning in terms of information flows. The third paradigm, in contrast, sees meaning and meaning construction as a central focus" (p. 7). This is similar to the earlier argument by Fallman. An example of embodied interaction comes from Dourish [26], who mostly discusses meaning in terms of understanding, although it is also implied to be core to good embodied interaction. He distinguishes three aspects of meaning: (1) *Ontology* concerns our relationship to the objects in the world, from which meaning can be constructed. That is, we uncover meaning in the world through our interactions with it. A design may reflect a particular set of ontological commitments on the part of a designer, but it cannot provide an ontology for the user. (2) *Intersubjectivity* is about the sharing of meaning, in a sense, that different people can come to shared understanding about the world and each other, despite not having access to each other's mental states. (3) *Intentionality* concerns the relationship between action and meaning. These offer a complementary view of meaning to the user experience accounts and claim that the world is already filled with meaning. Thus, meaning is a circumstance around good interaction rather than a characteristic of it.

In summary, studies have addressed meaning from a variety of angles. In user experience research, despite calls to afford 'moments of meaning' [41], research has largely ignored the experience of meaning [84]. To date, the majority of UX studies have focused on evaluating interactive systems in terms of usability-related constructs or positive affect [3, 95]. The most well-articulated accounts of meaning in HCI, from embodied interaction and in particular Dourish [26], deal mainly with meaning as a pervasive condition of the world and not as a quality of interaction per se. Thus, both the experience of meaning and meaningful outcomes of interaction are currently not well developed in HCI. Next we review work on meaning in psychology, which we will proceed to use as a basis for a framework of meaning.

Meaning Research in Psychology

Meaning research has a long and eventful history within psychology [refer to 5, 60, for more in-depth accounts]. Coming to terms with his experiences of the Holocaust, Frankl was among the first to emphasize 'man's will to meaning', the importance of finding value in life, even in the face of adversity and suffering [30]. This notion was taken up and further developed by existential psychologists [e.g., 5, 11, 121], who examine the role of meaning in coping with the "darker" aspects of human existence (e.g., alienation, mortality). Concurrently, Maslow argued that meaning (sometimes also referred to as self-actualization) constitutes a psychological need necessary for humans to flourish [80]. This perspective has been influential in positive psychology, which has only more recently acknowledged and researched the role of meaning in promoting well-being [94, 102].

From these two perspectives, existentialist and positive psychology, a growing body of research has emerged around the different psychological aspects of meaning. The first concerns *meaning in life* [34, 45, 78, 109], the second pertains to *meaning-making and meaning maintenance* [43, 91, 96]. The former aims to look at the subjective experiences of humans and asks what makes them *experience* meaning in their lives [34, 78]. According to empirical research into meaning in life, people have a general tendency to view their lives as meaningful [45], which acts as a buffer against the effects of stress on well-being [79], but also directly contributes to well-being [94, 102, 109]. If this sense of meaning is absent or threatened by stressful or incomprehensible events, people are motivated to create, maintain and reinstate meaning [43, 91, 96]. Despite the abundance of research showcasing the benefits of meaning in life, meaning-making and meaning maintenance, much empirical work has favored a reductionist approach that tends to measure 'meaning' in an overly simplistic manner (e.g., 'Compared to most of my peers, my life is meaningful' in [9]). Consequently, many meaning scholars in psychology [34, 45, 68, 78, 99] have called for more elaborate and nuanced definitions, which consider the complexity and conceptual range of meaning. Recent work has thus endeavoured to outline models of meaning [34, 91] and suggested various components that make up the experience of meaning [e.g., 34, 35, 45, 78].

3 MEANING FRAMEWORK

We next formulate a framework of five components of meaning. The purpose of the framework is to extract insights from the psychological literature on meaning in a form that is simple, actionable, and useful relative to the issues in HCI. We intend the framework to work as a conceptual tool to help analyze meaning in interaction, suggest open research questions about meaning and user experience, and clarify the nascent discussions about meaning in HCI.

The framework was developed by reviewing the works of contemporary meaning scholars within existential experimental and positive psychology [see 4, 34, 78, 118, for overviews]. In particular, we focus on research on meaning in life, meaning-making and meaning maintenance, which are of particular relevance to HCI [58]. We make no claim to cover psychological meaning research in its entirety. For instance, we acknowledge missing accounts, such as those

about logotherapy and meaning-centered counseling [e.g., 25, 117], or research on the meaning of work [e.g., 100].

The key idea of the framework is that the experience of meaning consists of five distinct, albeit related components – connectedness, purpose, coherence, resonance, and significance. Table 1 contains an overview of the components that the subsequent sections will explain. Before detailing the framework, however, three comments about the scope and assumptions of the framework are necessary. We return to challenge these assumptions in the discussion section.

Assumptions of the Framework

First, given its relevance for HCI and UX research, we focus on meaning as a moment-to-moment experience. While much psychological research focuses on people's global assessment of meaning in life, this is largely derived from their daily and situational experiences of meaning [38, 50, 61, 62, 74, 99]. Various phenomenological [68], 'evaluative' [92], or experiential [46, 54] components of meaning have been proposed in the literature. Although the terminology and definitions vary between authors, the framework components are discussed by a majority of the reviewed works.

A second assumption is that our framework conceptualizes meaning as a chiefly subjective experience. Rather than being objectively given in the world, we understand meaning as something personal, which must be subjectively generated (e.g., through meaning-making). This understanding is shared with many existentialist philosophers (e.g., Camus, Sartre) and psychologists [e.g., 32, 45, 78, 91, 121] – although there are several notable exceptions [e.g., 29, 30, 54, 68, 99].

A third assumption is that despite its vast and seemingly abstract nature, the experience of meaning is not ineffable. While the sources of meaning (i.e., *what* is experienced as meaningful) are manifold and may differ over time and from person to person [23, 99], the *experience* of meaning is universal [34, 45, 61, 78]. While we are wary of reductionist measures of meaning [e.g., 9], we take the position that the experience of meaning is made up of multiple facets, which can be conceptually defined and distinguished, as well as empirically assessed in some form [34, 35, 61, 78, 109]. Again, we do not claim that the framework captures the experience of meaning in all its complexity, nor that this is viable to do. Rather it outlines distinct 'projections' of meaning [68] in form of the five components.

Connectedness

By *connectedness* we refer to the fact that *the experience of meaning always connects beyond the immediate experience* [68, p. 461]. Meaning does not simply emerge from a vacuum, – all experience of meaning connects to aspects of the self and the world we are in. For example, many people report meaningful experiences involving video games [88], because those games have a personal connection. For others, video games constitute at best a pleasant, yet ultimately meaningless pastime [84], precisely because their experiences lack these connections.

The experience of meaning relates to and is constantly shaped by aspects of the self, including our past behaviors and experiences, personal beliefs and values, our goals and defining memories, as well as our relationships and sociocultural context [6, 7, 34, 43, 82, 91, 96, 99]. Hence, people sharing the same cultures, experiences, ideologies, and beliefs may consider similar experiences meaningful [7, 23, 34]. The opposite of connectedness is self-alienation [60]. Without a clear sense of self to help us make sense of our experiences or attribute personal significance, our sense of meaning is threatened in a fundamental way.

Importantly, connectedness does not per se refer to *the extent* that our experiences align with our personal values or preferences, only that these connections to the self underlie all experience of meaning. Thus, connectedness is essential to meaning [8, 44, 67, 96] and sometimes described as the *ontological dimension* of meaning [68]. Although we do not per se experience connectedness [68], it is a necessary prerequisite for the experiential components of meaning to form [78, 110]. Consider the case of associative prosopagnosia, where affected persons can perceive and differentiate faces, but may not be able to recognize and identify familiar people [31]. The lack of connectedness (e.g., where do I know this person from?) makes it difficult for affected people to make sense of the situation and understand the other person's significance to them. That being said, due to the unique, subjective and dynamic nature of the self [82], connectedness remains the most elusive attribute of meaning, making it particularly challenging to directly assess or design for [68].

Purpose

By *purpose*, we refer to having a sense of direction [78, 83, 102], perceiving one's current activities as having clear ends to strive towards [32, 34], as well as seeing how they are linked to future events [7, 75]. For instance, many people experience gardening as a purposeful leisure activity that offers short (e.g., mowing the lawn) and long-term goals (tending to the trees so that they can grow) to pursue. Purpose is therefore also referred to as the motivational component of meaning [78, 92, 99], and may be considered the future-oriented component of meaning. We question purpose when we ask "Why is this happening to me?" or "Why am I doing this?"

In a more extreme example, the protagonist in Roberto Benigni's film 'Life is Beautiful' is interned in a concentration camp with his young son. To overcome the futility of the situation and make it more bearable for his child, the

	Connectedness	Purpose	Coherence	Resonance	Significance
Meaning is ...	always connected to the self and the world	sense of core goals, aims, and directions	comprehensibility and making sense of one's experiences	clicking with something or feeling it is right	enduring value and importance
Absence	Self-alienation	Aimlessness	Absurdity and uncertainty	Feeling of 'wrongness' and anxiety	Triviality
Orientation	Self and the world	Motivation	Understanding	Feeling and Intuition	Mattering
Temporality	—	Present to Future	Past to Present	Present	Past, Present and Future
Process	Living	Goal-setting	Sense-making	Intuiting	Evaluating

Table 1: Overview of the five components of meaning.

protagonist frames it as a game with a clear purpose (e.g., "you must hide from the guards to win points!").

Indeed, Heintzelman and King argue that goals constitute one way in which 'humans beings construct and impose' meaning [44, p. 477], as they provide life with a series of connections and overarching order. In contrast, an enduring absence of purpose gives rise to a sense of aimlessness and amotivation, which is detrimental to one's well-being [22, 103]. Effectively, people find even trivial, short-term goals with no discernible benefit to themselves or others more motivating than the absence of purpose. Ariely et al. [2], for instance, found that participants chose to be more productive when provided a goal (i.e., to build as many Lego units as possible) rather than when no purpose was apparent.

The extent to which goals are experienced as meaningful, however, depends on the degree to which their pursuit is self-determined [101], as well as how closely they align with one's personal interests, beliefs and values [55, 82, 105, 114]. As such, for a sense of purpose to emerge it need be apparent how one's actions and short-term goals relate to one's higher-order aims, and values [32, 34, 103]. Importantly, purpose need not pertain to benefitting the self only, but may have 'broad implications' [54]. Several meaning researchers emphasized the self-transcendent character of meaning [30, 99, 118], where serious involvement with things beyond oneself and one's pleasure (e.g., rearing children, volunteer work) promote meaning [9], even if at the detriment to one's happiness. Concurrently, while having lofty aspirations imbues life with a sense of purpose and meaning [9, 82], failing to break them down into more concrete and achievable long- and short-term goals may eventually diminish one's sense of self-efficacy [7, 75] and happiness [82, 103].

To conclude, purpose is about experiencing a sense of direction and perceiving one's actions as tied to clear (higher) ends. Put differently, it is about experiencing how the given moment *joins with or relates to* our goals and beliefs. Without such joining or relating, our sense of purpose would be confined to the most immediate and impulsive goals [7].

Coherence

We use *coherence* to denote the extent to which one's experiences make sense [7, 34, 45, 54, 78, 99, 110]. The sense of coherence results from thinking about those experiences and understanding them in relation to life as a whole. It is the moment when we exclaim "I see what you did there" or state "that made sense to me". We question coherence when we ask ourselves "what is happening to me?" For instance, as absurd as it may seem to our friends that we structure vacation and work time around the CHI deadline, it makes sense to us—most of the time at least—as it is coherent with our identity as HCI researchers, our goal to write a good paper, and our previous experiences in doing so.

In the literature, this component has also been referred to as sense-making [43, 54, 96], comprehension [34], or sense made [91]. An event or experience makes sense to the extent that a person can assess how their experience fits their personal beliefs, goals and previous experiences in an expected way [7, 8, 54, 82]. Objects and images that are comprehensible or presented in an expected manner may also inspire a sense of coherence. For instance, Heintzelman et al. [48] found that study participants experienced more meaning after viewing pictures of trees ordered seasonally rather than when presented at random.

When this sense of coherence is perturbed or no coherence can be found—due to a perceptual anomaly [48, 64], a distressing life experience [91], mortality salience [108], or an acute awareness that unfortunate events randomly befall decent people [43, 96]—an experience may devolve into "a string of events that fails to coalesce into a unified, coherent whole" [109, p. 685]. Such experiences are unsettling and challenging, because they fail to readily connect to our

values or previous experiences; they are not as we expect [43, 91, 96, 99].

To establish or restore a sense of coherence people engage in different sense-making processes [91, 96]. These include relatively low-effort endeavors to reaffirm unrelated, existing connections (e.g., "My paper got rejected, but students value my teaching") or reframing the experience to meet one's expectations (e.g., "R2 surely had a bad day when they gave a low score"). However, more deliberate reflection to reconsider one's assumptions and create new connections (e.g., "R2 does have a point...") was largely found to be more beneficial to well-being in the long-term [91, 96].

In sum, coherence is about whether one's experiences make sense relative to our expectations. Thereby, it is different from purpose in that it is about understanding 'what' one is doing and experiencing rather than 'why' that is so.

Resonance

We use *resonance* to denote the immediate, unreflected experience of something making sense [54], without the need to reflect on why or how it does so, or being able to explain it. We assert "what is happening now feels right" [44, p. 473] or that something just "clicks" with us [54], indicating a special fit or connection. For example, we might have an intuition, a positive 'gut feeling', that what we are doing and experiencing right now is 'right': Reading a poem or gazing at a beautiful landscape might resonate strongly with us. Perhaps we know more than we can tell [44], such as when practicing yoga, one notices that the pose feels 'right'.

Resonance is related to, albeit experientially distinct from coherence. While conscious and more active reflective processes are often central to research on meaning, comprehension and sense-making [34, 43, 91, 96], the notion of resonance has received far less attention. Yet recent work has argued that not all meaning people experience is actively construed and that people often experience events as intuitively and instantaneously meaningful [44, 47], whereby one's 'link with an experience or activity has an echo, a second dimension that makes it more vibrant and real' [54, p. 21]. This has also been referred to as the 'feeling of meaning' [46, 49], which Heintzelman and King [46, 48] argued is distinct from affective responses. Moreover, a recent study of theirs showed that the experience of meaning in life was positively associated with intuition [47].

In short, while coherence is about understanding how one's experiences fit with what we know about ourselves and the world, resonance denotes a pronounced feeling of 'rightness' that emerges spontaneously in response to one's ongoing experience connecting with one's self in some way.

Significance

Finally, we refer to *significance* as the sense that our experiences and actions at a given moment feel important and worthwhile, yet also consequential and enduring [7, 34, 62, 78]. In short, the experience underlines that our existence is non-trivial. It is when we state that things "matter" and "make a difference". For instance, some activities and experiences bring us little to no pleasure—in fact, we might feel quite ambivalent or even bad about them. Yet we deem them deeply important: Breaking up with an estranged partner, or dedicating considerable time and effort to improve a work that hardly anyone will ever see.

Indeed, the notion of significance has also been referred to as value [7, 54, 75], mattering [33, 34], as well as the affective [92] or evaluative [54, 78] component of meaning. Like resonance, it has received far less attention in empirical meaning research [33, 34], but is implicit in many earlier conceptualizations of meaning. Baumeister, for instance, noted that "A person wants his or her life to make an interesting or inspiring story, to exemplify a high theme or lesson, or to be part of grand and important developments [...] that all of this has some profound, lasting importance" [7, p. 61]. Similarly, the notion of significance is also implicit in Terror Management Theory [TMT; 64, 108], where people seek symbolic immortality – i.e., to feel part of something larger, more significant, and more enduring than their own individual lives – to assuage death anxiety [43]. TMT research typically operationalizes this as self-esteem, where participants rate their sense of personal worth relative to other people. However, this constitutes a somewhat narrow perspective limited to social comparison [33]. Rather, significance is more about evaluating events and experiences relative to one's personal values [7, 34, 78].

To sum up, while significance somewhat resembles the notion of resonance, resonance is about an intuitive feeling of things making sense in the moment. In contrast, significance is about having a sense that one's experiences matter to one's life and beyond, rendering them valuable and precious.

Relation Among the Components of Meaning

The five components of meaning are distinct, but it would be inaccurate to see them as separate and orthogonal. Connectedness is at the core of the experience of meaning. If our experiences did not connect to anything, we would not be able to make sense of them (coherence), develop any gut feelings (resonance), recognize their purpose to us, or be able to assess their significance in light of our personal values. Conversely, experiencing coherence, resonance, significance and purpose provides further connections and order between aspects of the self – we become more aware of what matters to us, our personal goals, what feels right, as well as how our

experiences fit with our previous experiences. This also entails that – in contrast to happiness and pleasure, which are mostly present oriented [9, 59], – the experience of meaning connects to the past, present and future [9, 59].

Similarly, the experiential components of meaning are interconnected in complex ways. Coherence arguably constitutes a necessary condition for purpose, resonance and significance: If we cannot make sense of our experiences, they feel wrong, and it is difficult to evaluate whether they matter to us and set future goals. But a sense of coherence alone will not automatically render our experiences purposeful or significant. Having goals to which one is committed (purpose), likely generates a sense of significance [32], 'stimulate(s) behavioral consistency' [83, p. 248] contributing to a sense of coherence, as well as provides an indication of whether one's actions feel right.

Importantly, while our framework focuses on the moment-to-moment experience of meaning, it need be reiterated that meaning is never solely about one specific moment in time. Purpose as a future-oriented goal can lend significance to the present moment [78]. Significance, in turn, is not bound to a certain form of temporality, as we may derive a sense of significance from our future goals, our past experiences and from the present moment. Meanwhile, it may take considerable time until we can make coherent sense of our experience. Moreover, while coherence, purpose, and significance concern different dimensions of experience, they all require reflective and interpretative efforts from us [78] in the form of sense-making, setting and assessing goals, and evaluating the significance of events respectively. A crucial exception is resonance, however, which is intuitive and spontaneous [47]. Nevertheless, each component impacts the other and the combined experience of the meaning components reinforces and intensifies the experiencing of each one [34, 78, 99].

4 CHI AUTHORS ON MEANING

To illustrate the use of the framework, we present an analysis of how CHI authors write about meaning. The purpose is to bring the framework in touch with recent work using the concept of meaning and thereby illustrate both its components and its benefits to HCI. While such a discussion is necessarily superficial because we cannot account in-depth for each of the papers and their discussions of meaning, we nevertheless believe it raises some important discussions about meaning that have not previously been articulated.

To identify papers about meaning, we used dl.acm.org to search the past three year of the CHI conference for papers that intensively used the concept of meaning. We ranked the retrieved papers on the number of occurrences of the word 'meaning*', and browsed titles and abstracts to identify papers that used meaning in ways beyond reference or sense. For instance, Wiseman and Gould [116] analyzed how emojis are repurposed in personalized and secretive ways. Their paper is not, however, about meaning in a psychological sense and was not of interest to our analysis. Based on these considerations, we selected 20 papers as our sample (marked with an * in the References). Reading and relating these papers to our framework gave rise to several observations and discussion points; next we raise four such points.

The Many Meanings of "Meaning"

Our analysis of the CHI sample suggests that *meaning is a complex phenomenon*, with many different senses and interpretations. One way this becomes apparent is that the term 'meaning*' is used to describe the user experience [12, 65], activities (e.g., data being made "socially meaningful" [53]), artifacts [27, 57], or the user's interpretation of the interaction [18, 24, 63, 76]—often all within the same paper [e.g., 17, 85]. While this suggests that meaning is valued as a quality of interaction, none of the reviewed papers make explicit what they mean by 'meaning' (or 'meaningful' or 'meaning-making'). Even when meaning is central, as suggested by several papers featuring 'meaning*' in the title [56, 76, 84, 86], no definition is provided.

As mentioned, we excluded many instances of commonsense uses of meaning. A more tricky issue is what to make of situations where uses of the term meaning could be replaced with learning, understanding, or developing a mental model. For instance, Malinverni et al. [76] used the terms meaning-making, sense-making and understanding interchangeably to describe how through different AR interaction paradigms, children interpreted their environment as a place to play with or as a mediated image. In this case, the framework we have described, with its psychological underpinnings, may not apply and a set of much simpler mechanisms might be used in its place; mechanisms that are perhaps much more well-developed in HCI.

The individual papers do the discussion of the specifics of meaning more justice than we can do. Nevertheless, the variety of uses of the term meaning is confusing in trying to appreciate the individual papers, the processes involved in the experiences of meaning, and their interrelation.

The Components of Meaning in HCI Papers

Another way of seeing the complexity of meaning is that *all senses of meaning in our framework are represented* in the papers. Landwehr-Sydow et al. [65] explored maker culture, for instance, and noted "how taking things apart can be meaningful as an activity" (p. 123), shaped by "acts of subjective meaning making and interpretation" (p. 123). These interpretations involve both users' material literacy (i.e., their skills and previous experiences) and the characteristics of the artifact (e.g., affordances, material qualities). This highlights

the role of *connectedness* for sense-making and meaningful experience to occur. Similarly, Devendorf et al. implied the notion of connectedness by noting that "the meaning of something is established among a web of associations with other meaningful things" [24, p. 6032].

The notion of meaning as *coherence* was particularly prominent in research on making sense of data [53, 86, 98]. For example, in a study on self-tracking in World of Warcraft (WoW), a participant noted that "it is strange how at the beginning of my experience in WoW all these data were confusing, quite meaningless for me" [98, p. 4]. While clearly denoting an absence of coherence, this example is mainly about the data at first not being consistent with the users' previous experiences. In another study, Houben et al. specifically employed physicalization "to make the data more meaningful by [...] help(ing) users become interested in, and understand the data streams more in the context of their own lives." [53, p. 1610], which more fully reflects the notion of coherence outlined in our framework.

Several papers also refer to meaning as *purpose*. Niess and Wozniak [86], for example, discussed "meaningful (fitness) tracker goals" and "meaningful transitions between goals", while Mekler and Hornbæk's work on eudaimonic experiences suggests higher order goals (e.g., "Seeking to pursue excellence", [84, p. 4511]). Similarly, Brewer and Piper identified blogging as "a source of meaningful engagement for older adults by providing a focal activity" and "a sense of meaningful engagement [...] from creating an artifact that is valuable to others" [13, p. 5538]. Theses uses of meaning echo the notions of purpose and significance in our framework, where blogging affords older adults with clear and valued future goals to impact others' lives positively, and which may have been missing after retirement from work.

Other instances of meaning as *significance* pertain to how cancer survivors regard their tattoos as "meaningful artifacts" that facilitate and symbolize post-traumatic growth [27], or "meaningful choices [...] through which the player can significantly impact the course of the game" [56, p. 2]. In another example, Gruning noted that "maintenance actions such as keeping and deletion of e-books were less meaningful actions than they were when taken with paper books" [37, p. 7], where one of her participants commented that "because (e-books are) invisible. They don't matter" (p. 139). This echoes our understanding of significance being about worthwhile and consequential interactions.

The notion of meaning as *resonance* was less apparent. Ambe et al. [1] discussed an augmented clock that displays all family members' whereabouts, regardless of whether they share the same home: "The object is no longer just an everyday object but a connection to loved ones and a feeling of togetherness" (p. 6640). While the authors stress that these interactions only became meaningful over time through everyday practices, the resulting feeling of togetherness is likely spontaneous and arguably more about resonance. Of particular note is also work on designing for people with dementia [66, 85], which highlights the role of aesthetic and embodied interactions that resonate with people's "own self, history and proficiencies which were still very present" [85, p. 1131], even though their sense-making processes might be altered or compromised [66, 85].

How To Design for Meaning

Some of the sampled papers discuss *how to design for meaning*. We find a number of those discussions superficial, given the complexity of meaning as captured in our framework and in the broader psychological literature. For instance, Niess and Wozniak claimed that "being aware of the user's qualitative goals will enable designing systems that link them to hedonic and eudaimonic needs. This, in turn, will enable suggesting meaningful qualitative goals that foster reflection" [86, p. 9]. Similarly, a study on how game elements support sense-making stated that: "Instruments like askmrrobots, therefore, can quickly recommend the optimal gear to wear, representing a valuable aid to make players' numbers meaningful without requiring strong efforts from them" [98, p. 6]. Both quotes suggest that the experience of meaning comes easy, provided it is targeted accordingly through design. In contrast, Ambe et al. stressed that "the added meanings, contributed by the users themselves, are personal, encouraged but not provided by design" [1, p. 6639].

Sometimes the design suggestions are about ambiguity [e.g., 17, 24, 107]. For instance, in an empirical exploration of mindfulness design, it was suggested that "By distorting the displayed information, the system makes the representation 'imprecise' and thus requires users to 'fill in the gaps in the information'. This allows users to identify their own focus and create new meaning" [17, p. 6]. While this likely initiates sense-making processes to establish a sense of coherence, it is not clear whether this would also afford users with a sense of purpose, resonance, or significance.

Reflection and Meaning

We observed several assumptions about *how reflection relates to meaning*. Some work equates the experience of meaning and reflection, as in the case of studies measuring 'appreciation' [e.g., 12, 56], "an experiential state characterized by the perception of deeper meaning [...] and the motivation to elaborate on thoughts and feelings inspired by the experience" [87, p. 76]. Others included measures of 'meaningful affect' [12, 84] to assess how introspective users felt [89]. However, these operationalizations make it unclear whether

meaning is an outcome of reflection, whether meaningful experiences are more likely to promote reflection, or both.

Some papers specifically refer to reflection giving rise to meaning, as in the case of a data physicalization kit having "helped the participants to think and reflect on the data changes and made it more meaningful when looking at the data provided" [53, p. 1616]. Others highlight the role of reflection for making sense of one's identity and gaining self-knowledge [13, 98]. In that sense, reflection is chiefly about establishing a sense of coherence, both with regards to the world (e.g., data) and oneself.

However, reflection was not only about coherence. A participant from a study on mindfulness design stated that [17, p. 9]: "through reflection I can [...] figure out what is the most important for me and what is actually critical for me". In another example, users could repurpose text messages into haikus [107], which facilitated an 'interpretative process in which new meanings and relationships are created by re-evaluating existing ones [...] thereby creating significant and meaningful intersections' (p. 848). Both examples suggest that the reflection afforded through interaction led users to evaluate the significance of their experience. In another example, reflection is linked to a sense of purpose: "This shows how the user trusts the goal to be meaningful and expects to be able to reflect upon it" [86, p. 7].

These observations lend credence to the notion that reflective efforts are required to give rise to a sense of purpose, coherence and significance [78]. However, we note that perhaps the CHI papers overstate the role of reflection for meaning, potentially neglecting the intuitive and unreflected experience of resonance.

5 DISCUSSION

Meaning is of increasing interest to academia and industry. However, the notion of meaning, and particularly the experience of meaning in interaction, remains elusive and a bewildering number of senses are in use. This paper contributes to conceptual problem-solving in HCI [90] by presenting a framework of the experience of meaning. We have detailed five components, as well as their orientation, processes, and interrelations, which clarify the user experience of meaning as a quality of interaction. The framework was illustrated by applying it to analyze a selection of CHI papers. Below we discuss benefits and drawbacks of the framework and present some of its other uses, in particular, how it can help identify open questions in HCI about meaning.

Benefits of the Framework

The framework we propose has attempted to do something rarely done in individual papers, including the sample of CHI papers we analyzed: It has created an overview of an important quality of interaction, meaning. Outside of HCI, Leontiev [68] nicely summarized this endeavor: "to embrace meaning in all its complexity is hardly to be expected in specific studies, the point is respecting the complexity and keeping in mind its varied facets to locate separate studies in the grand scheme of meaning" (p. 469). This overview serves as a starting point for discussing the experience of meaning that is lacking from many papers, even those with a claimed interest in meaning [e.g., 41, 58]. The sample of CHI papers that we analyzed also benefited, at least in our view, from an overview of and distinction between components of meaning.

This overview goes beyond existing views of meaning in HCI, but we acknowledge an overlap of individual components with earlier work. Connectedness has some overlap with Dourish's notion of ontology, whereby designs may reflect ontologies, but not provide them [26]. Significance shares some overlap with Cockton's understanding of worth [19]. And purpose is related to Hassenzahl's notion of be-goals [40]. However, the full complexity of meaning is rarely addressed in HCI; integrating them, as in our proposed framework, allows reasoning about all of them, as well as appreciating their relative differences.

We argue that the framework can also provide some input to design and evaluation. With respect to design, Dourish has noticed that "meaning is a vague term. Connecting it to design will require more precision" [26, p.128]. Distinguishing the five components in design is useful, and our analysis highlights several avenues for doing so. For example, designers of technologies aimed at making data "meaningful" [53, 98] may not only focus on coherence, but also deliberately consider ways for users to perceive data as purposeful, resonant and significant. And while connectedness does not per se constitute an experiential component of meaning, design might still facilitate connectedness – and therefore the experience of meaning, – by helping bring certain aspects of one's self and the world to the fore, making them available to evaluating their personal meaning to us (e.g., the augmented clock [1], where one can choose which family members' whereabouts to have displayed at all times). Relatedly, our analysis of CHI papers suggests that a grip on the complexity of meaning-making might also help better justify design decisions. For instance, when considering whether and how ambiguous interactions may give rise to a sense of coherence, purpose, resonance and/or significance.

Moreover, our framework may also provide the starting point for considering meaning as an experience goal [71] when designing products beyond the work place, as it provides a clearer understanding of the different components and orientations of meaning. Another promising avenue for future work is to link the five components to specific design qualities. For example, through its focus on identity, the pregnancy wearable designed by Carpenter and Overholt

[16] likely affords the non-pregnant partner with a sense of resonance, while the focus on enabling stories may facilitate the experience of coherence and significance.

For evaluation, it is a difficult empirical problem to understand what people experience as meaningful interactions with technology; both in terms of assessing meaning qualitatively and quantitatively and in terms of understanding the contents of their meaning-making. Previous research provides some starting points [40, 72, 84], but usually makes simplistic assessments of meaning. Based on our framework, we recommend researchers to consider measures that account for different components of meaning. For instance, the Existential Meaning scale [35] and Huta's meaningful experience scale [54, 55] include dimensions that reflect the notions of coherence, significance, and purpose. With regards to resonance, Huta [54] suggests the Personal Expressiveness scale [115], which includes items such as "I feel a special fit or meshing when engaging in this activity". We are, however, not aware of any studies within psychological meaning research having already done so. Lastly, meaning scholars [e.g., 68] have stressed that connectedness cannot be readily assessed. However, the absence of connectedness might perhaps be approximated by utilizing the self-alienation subscale (e.g., "I feel as if I don't know myself really well") from Wood et al's Authenticity scale [120].

Limitations of the Framework

As mentioned in the presentation of the framework, we work from at least three assumptions that deserve critical discussion; some of them are limitations of our work. Most importantly, because we ground our framework in existential and positive psychology, we describe meaning as a subjective experience. However, there is an ongoing discussion, also in the fields we draw on, whether there is also something such as objective meaning in the world or intersubjective meaning [29, 68]. We acknowledge this as a limitation due to our point of departure from the experience of interaction.

More specifically, in synthesizing the framework, we made selections for the components of meaning. Many other components could be formulated [99] and might matter to HCI. For instance, Wong proposed 'responsible action' as the behavioral and objective component of the experience of meaning [119], while MacKenzie and Baumeister refer to the intersubjective nature of meaning by describing it as a 'shared mental representation of possible relationships among things, relationships, and events.' [75, p. 26].

The framework is currently silent about the *content* of experiences of meaning in interaction. This is due to our focus on the experience of meaning, rather than the sources of meaning (or what is experienced as meaningful); a focus shared by much of meaning psychology [34, 45, 61, 78]. However, this makes the framework abstract. We have tried to provide illustrative examples for the five components in the analysis of CHI papers, but acknowledge a need to exemplify the framework with examples and narratives of sources of meaning and concrete meaning-making processes. Empirical work using the framework could provide such examples.

Similarly, due to our focus on the *experience* of meaning in interaction, our framework says little about the *meanings* of interaction [26, 39, 104]. Indeed, many papers in our analysis referred to meaning in the latter sense. While beyond scope for the present work, we argue that for a comprehensive understanding of meaning-making in HCI [58], both perspectives need to be taken into account, akin to Park's work on the relationship between meaning-making and meaning in life [34, 91]. For instance, one's interpretations of interaction (i.e., its meaning) likely relate to one's sense of coherence, whereas it is unlikely that all 'meanings' are accompanied by the experience of purpose, significance, or resonance.

Open Questions About Meaning in HCI

The framework also works to identify a host of open questions about meaning in HCI; we have already given some of them in the analysis of CHI papers. For instance, several papers mixed together different senses of meaning [e.g., 17, 56] to the detriment of the clarity of their analysis. Here we give a few additional open research questions. First, recent psychological meaning research has created a few scales that capture different components of the subjective experience of meaning [35, 54, 55]. Those scales are exciting to use in HCI, but currently no operationalisation of all the components outlined in our framework exists; developing such an operationalisation is valuable future work [15].

Second, maintaining a sense of coherence is generally beneficial, but deliberately targeting designs at undermining the experience of coherence (e.g., ambiguous interactions [17, 107]) may afford opportunities to reflect on, perhaps reconsider what has previously been taken for granted and gain new insights ('make new meanings'). The framework outlines some sense-making processes by which coherence is created; we believe they are of importance to thinking about the meaning of experiences in HCI. Ideas for designs that might do this could help finding patterns in experiences, help foster predictability, and help think about patterns in one's life. While such applications exist [e.g., 113], relating them to meaning-making has not happened as far as we know. On a similar note, future work should endeavour to unpack the relation between reflection, meaning-making and the experience of meaning.

Third, coherence is related to learning and understanding. It would be valuable to understand this in the context of relating events to how they fit into one's life. Granted, the psychological literature tends to conflate these two related notions [e.g., 48]. But how does, for instance, the experience

of coherence and learning coincide in different contexts and use cases? It would be illuminating, for instance, to examine under what circumstances making sense of data [e.g., 53, 111] is also experienced as purposeful, resonant and significant.

Fourth, we have proposed the notion of resonance. We think it is particularly useful when discussing non-reflective meaning, for instance, in researching interactions that put bodily experiences at the fore [51], and settings where people might not be able to readily articulate their experiences in a verbal manner [e.g., people with dementia, 66, 85].

Fifth, our discussion of purpose relates to how technology may help people set personally valued goals and support them in their pursuit. This happens, for instance, in personal and reflective informatics [10, 86, 111]. We see two important questions that our framework might help drive: (1) How to support people in identifying themselves the aims and goals that they truly value (because this is not always evident [82, 105]) rather than some personalized solution (see 'bovine design' in [69, 70]); and (2) How to support people, once those higher level goals have been identified, in setting and striving towards more manageable, yet meaningful lower level goals. These are not new questions, but questions that a framework of meaning might constructively contribute to addressing.

Finally, it would prove fruitful to link the five components to previous UX research on meaning. For example, Martela et al. recently found psychological need satisfaction predictive of meaning in life [77], lending credence to the claim that need satisfaction contributes to meaningful user experiences [41]. It is yet to be empirically examined to what extent the five components relate to the satisfaction of individual needs, or which interactions users consider particularly coherent, purposeful, resonant and/or significant [72].

6 CONCLUSION

Meaningful experiences in interaction or as outcomes of interaction are becoming of increasing industrial and academic interest. However, the intended senses of meaning and their implications for HCI are flummoxed. From the psychological literature on meaning, we have extracted five components of meaning into a framework that appears useful to human-computer interaction. We have shown that these components are useful for analyzing existing papers on meaning and for identifying open questions about the experience of meaning in human-computer interaction. Improved clarity about meaning might in turn help make worthwhile computing that contributes to users' well-being.

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