THE NUANCE OF NEED

MAPPING USER NEEDS THROUGHOUT THE DESIGN PROCESS

JAMES RUDOLPH
UNIVERSITY OF NOTRE DAME

PAPER ABSTRACT: There is a common misconception that human needs exist primarily independent of designed products, services, and systems available in the built environment. A more nuanced examination of need, however, reveals that sometimes the opposite is true – solutions do indeed drive our goals as well as the needs required to fulfill these goals. In this paper, the author explores the relationship between human need, goals, and the designed world. The author then explores the implications for design practice, reframing the discussion for design professionals through a theoretical framework for integrating need identification, understanding, and validation throughout a holistic design process.
Keywords: Design thinking; design process theory; user needs; reflection-in-action.

1. INTRODUCTION

The field of design is full of principles, or guidelines, for practicing design with strategic rigor on the path towards successful design solutions. Two design principles loom increasingly large: 1) Develop a good understanding of the user; and 2) Follow good design process. As such, much has been written and researched for how to develop an empathic understanding of people and for how to strategically and systematically turn this profound understanding into successful design interventions. Liedtka and Ogilvie (2011, p. 6): "Design starts with empathy, establishing a deep understanding of those we are designing for… It involves developing an understanding of both their emotional and their "rational" needs and wants." Many similar examples can be found in recent publications, both academic and popular, on design thinking. It is no surprise, then, that even a cursory review of recent design research publications yields hundreds of user research methods and design process models (for a small sample, see, Bella & Hanington, 2012) for an increasingly wide range of applications.

Despite the importance placed on understanding need, the author's own research has uncovered conflicting understandings of need amongst design practitioners and academics alike (Rudolph, 2020a; Rudolph, 2020b). Similarly, very little research has explored how different types of need are identified throughout the various phases of design development. How are we to advocate for understanding users and following good practice if we have not made explicit the direct links between these two (user needs, design process) critical areas of study? If we aspire to create a holistic design process, one that thoroughly considers the inherent complexities of our diverse experiences, we must endeavor to outline a design process that explicates the various typologies of need throughout a strategic design process. Two important questions emerge: How do product development teams define and identify need(s)? How does their understanding of need impact their design process? These questions are investigated through three phases of inquiry: 1) An analysis of the definition(s) and categorization(s) of need, as outlined by research in cognitive psychology and human-computer interaction, is conducted; 2) A review of design process theory, associated models, and creative problem solving is outlined, highlighting similarities and overlap for selecting a design process model exemplar; and, 3) Development of a novel conceptual framework for mapping needs throughout the development process is discussed, including limitations and areas for further research.

2. DEFINING NEED

There is general consensus within the design research community that understanding a prospective user and his or her needs is critical for identifying important problems to solve (Schön, 1983), conducting successful product development, and supporting business growth (Liedtka & Ogilvie, 2011; Lockwood, 2009). Similarly, the U.S. Food and Drug Administration (FDA, 2011), which regulates medical device development in the USA, has mandated: "Each manufacturer shall establish and maintain procedures to ensure that the design requirements relating to a device are appropriate and address the intended use of the device, including the needs of the user and patient." Despite overwhelming support for understanding needs, previous research has revealed often disparate interpretations of need (Rudolph, 2020b). Merriam-Webster's online dictionary (n.d.) definition of need supports the common interpretation amongst design researchers and practitioners:

> 1: necessary duty, obligation; 2: a) lack of something requisite, desirable or useful; b) a physiological or psychological requirement for the well-being of an organism; 3: a condition requiring supply or relief; 4: lack of the means of subsistence.

Historically, need has often been defined as the physiological or psychological requisite(s) to achieve a higher-level human goal, such as self-actualization (Maslow, 1970). There exists a lengthy epistemological history of universal needs definitions and taxonomies. Maslow (1970) outlined five needs in his *Theory of Human Motivation*, Sheldon, et al. (2010) identified ten psychological needs, the Center for Nonviolent Communication (2005) outlined 75 universal needs separated into 7 categories, and Deci & Ryan (2000) reduced the number to three. The number and organization of *universal* needs are, however, irrelevant, as the examples discussed here focus primarily on the fulfillment of self-actualization, improvement, personal betterment, etc.

More importantly, perhaps, is the relationship between needs and goals. In all cases noted above, the needs are the 'physiological or psychological requirement[s]' for achieving the stated goal (e.g., well-being, self-actualization, etc.). To put it simply, needs are the missing element, the 'lack of something requisite,' for achieving the goal. Wants, desires, and wishes all behave similarly to goals – they are aspirational targets *to-be-achieved*. The difference between goals, wants, desires, etc., is a matter of degrees – the time, effort, and resources expended to achieve the aspirational target. The requisite or missing elements to achieve these aspirations, however, can always be defined as *the need*. The need is never the target, but rather the means by which one achieves his or her goals.

What happens when the goals are more specific or, perhaps, less lofty than Maslow's goal of human 'self-actualization'? The distinction between universal (though certainly not universally accepted) needs and other types of need requires we define a more nuanced categorization of needs, one based on the type of goal to-be-achieved.

3. CATEGORIZATION OF NEEDS

If universal needs are intended to outline the basic psychological and physiological requirements for achieving "everything that one is capable of becoming" (Maslow, 1970, p. 13), where does this leave needs that are highly context or culturally dependent? What is the relationship between practical everyday needs and the somewhat loftier universal needs?

Fortunately, this question has been explored in the fields of both psychology and human computer interaction. The seminal work of social and personality psychologists, Carver and Scheier (1998), explores human motivation and goal-directed activities and their impact on one's behavior and decision making. Based on their research, they postulate a 3-level hierarchal organization of goals, including: 1) *motor-goals* (physical interactions); 2) *do-goals* (tasks or activities); and 3) *be-goals* (basic human psychological needs that motivate action). The 3-level organization of goals is important because it suggests there are different typologies of need. Needs can be defined as the 'requisite' elements for achieving the three distinct types of goals, and categorized according to the type of goal being addressed. An overview of the relationship between needs and goals is outlined in Figure 1 below.

Figure 1. A visual representation of Carver and Scheier's 3-level organization of goals with the associated need-types required to fulfill these goals.

The 3-level categorization of goals is critical to understanding the different types of needs that must be addressed during the design process. Some needs, especially those that are required to achieve *do-* or *motor-goals*, are inescapably linked to a product or system (e.g., the solution). For example, an orthopedic surgeon conducting an ACL repair using traditional laparoscopic instruments will have significantly different needs than a surgeon conducting an ACL repair using a surgical robot. In this example, the goal appears at first glance to be largely the same (to conduct successful ACL repair), but the requirements (needs) necessary to conduct the repair (e.g., knowledge, surgical tools, steps, physical capabilities, etc.) are largely defined by the selected solution space (traditional laparoscopic instruments vs. surgical robot). The user's goals, therefore, are very much "mediated by the interactive product" (Hassenzahl, 2010, p. 11). The *do-* and *motor-goals* change depending on the solution to-be-interacted with and, as such, the needs required to effectively achieve one's goals are largely dependent on the selected interactive solution. This further emphasizes the importance of understanding need(s) through the lens of all three goal types (*motor-goals, do-goals, be-goals*) throughout the design process.

Combinatory play with Carver and Scheier's 3-level categorization of goals reveals an alternative way of understanding two common goals in design: 1) Framing the problem, and 2) Defining the solution space.

Framing the problem. The combination of *be-goals* and *do-goals* defines the problem space – the tasks people are attempting to accomplish and the motivations driving their behavior. In many ways, this is what Schön infers when he uses the phrase 'framing the problem.' This is the same logic that supports the Nielsen Norman Group's recommended structure for creating a 'user need statement': "Traditional need statements have 3 components: 1) a user, 2) a need, and 3) a goal" (Gibbons, 2019). Importantly, neither the conceptual direction nor the technology required to implement a solution are required to be defined at this point. According to previous research (Rudolph, 2020b), this is the combination of goals that many practicing designers define as a need. Nevertheless, defining the problem space can be understood as developing a clear understanding of *be-* and *do-goals*.

Defining the solution space. The combination of *do-goals* and *motor-goals*, on the other hand, informs the solution space. The goals in these two categories are largely determined by the constraints defined by the conceptual design direction, including selected technologies, and must be validated to ensure successful interaction with the product, service, or system. *Motor-goals*, driven entirely by the designed experience, will become more apparent and specific as the solution is further developed. See Figure 2 below for a visual representation of this general framework.

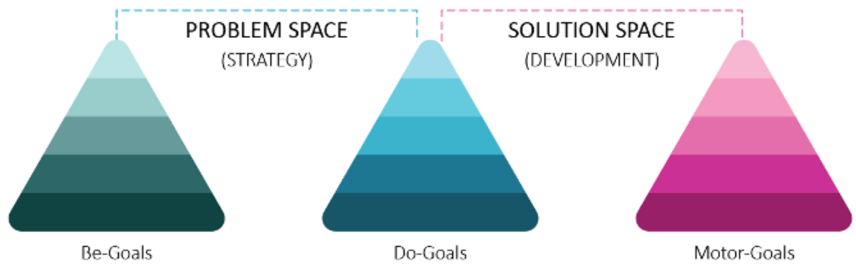

Figure 2. *Be-goals* combined with *do-goals* determine the problem space – defining the 'what' and 'why' of the design opportunity. *Do-goals* combined with *motor-goals* determine the solution space – defining 'how' the solution works to achieve specific tasks.

Towards a Holistic Design Approach. As has been discussed, needs are always *in-the-service-of* a goal, and goals can be largely defined by a 3-tiered hierarchy of motivation. As Hassenzahl (2010, p. 13) suggests: "Designing and evaluating experiences implies to take all three levels seriously." So far, we have established how these needs might be considered in defining two distinct areas of the design process (framing the problem, defining the solution space), but there is clearly more to be considered. If we are to achieve a more holistic design process, one that considers the various types of needs, we will need to consider how these needs are integrated into a more robust design process, one that allows us to deal with complex challenges and directs us towards an effective solution in an organized manner.

4. DESIGN PROCESS THEORY AND MODELS

4.1 DEFINING PROCESS THEORY

Liedtka and Ogilvie (2011, p. 8): "But design brings more than just a set of principles; it also brings a methodology and a collection of tools that can help us realize those aspirations." Design process theory provides the structural, often sequential, framework to guide strategic problem solving. Design process theory, historically, has been communicated in the form of a process model – a series of activities, methods, or phases of work aiding in the flow from 'problem space' to 'solution space.' The individual methods, often conducted to achieve specific goals, are combined into 'phases' of work with higher-level objectives (e.g., defining the problem, developing novel ideas, etc.). In industry, design process models have often been used to ensure a consistent approach to design, to enable a reliable culture for design teams, and to ensure design teams follow industry best principles and practices (Iversen, Kunø, Vistisen, 2018). The complexity of the model will, of course, vary greatly depending on the domain, context, and complexity of challenge being addressed.

4.2 PROCESS MODELS – HISTORICAL OVERVIEW

Various design process models have been proposed over the last century, many of which can be attributed to early research in creative problem solving (Boden, 1991) and the subsequent Design Methods Movement of the 1960s (Cross, 1984). The Design Methods Movement, in particular, aimed to discover the underlying logic of designing and developing a universal design approach in the style of the scientific method (Beck & Stolterman, 2018). The interplay of experience, observation, reflection, concept development, and evaluation, seen in Kolb's *Model of Experiential Learning* (1984), has had significant influence on the more recent Design Thinking movement (Hugentobler, Jonas, Rahe, 2004).

With renewed interest in the design process over the past thirty years or so, creative problem-solving models have been adapted for a wide range of applications and fields of study, including brand and customer experience (Lockwood, 2009), innovation (Brown & Wyatt, 201; Verganti, 2009), business (Brown & Kātz, 2009), project management (Dunne & Martin, 2006; Liedtka & Ogilvie, 2011), social change (Brown & Wyatt, 2010), and service design (Stickdorn, Schneider, & Andrews, 2011), to name just a few. While many of the design process models are communicated using memorable acronyms and visual metaphors, such as the double diamond (Design Council, 2019) or funnel (FDA, 2011), the processes share significant overlap in content, sequence, and advocacy for an iterative process of ideation, prototyping, and testing with representative users. See Table 1 below for a small sample of existing design process models.

Wallas (1926)	Preparation	Incubation	Intimation	Illumination
Osborn (1963)	Fact-finding	Idea-finding	Solution-finding	
Parnes (1981)	Mess-finding	Problem-finding	Idea-finding	Solution-finding
Schneiderman (2000)	Collect	Relate	Create	Donate
Brown & Kātz (2009)	Inspiration	Ideation	Validation	
Stickdorn et al. (2011)	What is?	What if?	What wows?	What works?
UK Design Council (2019)	Discover	Define	Develop	Deliver

Table 1. Sample of design process models.

4.2 ESTABLISHING A DESIGN PROCESS MODEL EXAMPLAR

Howard, Culley, & Dekonick (2008) conducted extensive analysis of design process models, comparing models outlined in engineering design research to models outlined in creativity, and found significant consistency amongst the models. Models in engineering design, for example, could be roughly organized into 6 distinct phases of work: 1) Establishing a need; 2) Analysis of a task; 3) Conceptual design; 4) Embodiment design; 5) Detailed design; and 6) Validation. Analysis of 'creative' process models yielded 4 distinct phases of work: 1) Analysis; 2) Generation; 3) Evaluation; and 4) Validation. Engineering models, as outlined above, tend to divide *analysis* and *Validation* into two separate phases of work. This is not to suggest that one model alone is absolute, perfect, or correct, but the overlap serves to highlight a cumulative foundation of knowledge in design research and design process models, building off previous research, knowledge, and practice (Beck & Stolterman, 2018).

The consistency between existing design process models is clear, and can be generally summarized as: Design informed by an empathic understanding of the user and his or her needs; Divergent ideation, often involving both representative users and multi-disciplinary teams; Rapid prototyping and hands-on experimentation and refinement; and, Iterative cycles of testing, evaluation, and down-selection. These phases often take place concurrently with business analysis and planning (Liedtka & Ogilvie, 2011), and have become synonymous with the principles and practices of *design thinking* (Lockwood, 2009). The verbiage used to describe the phases of design process are, perhaps, not important. The objectives of each phase are, however, critically important as it is the objectives of each phase that help define which goals and needs should be addressed throughout the design process. For purposes of clarity, four distinct phases have been selected as an appropriate design process model exemplar for integrating need identification throughout the design process: 1) Immersion; 2) Ideation; 3) Refinement; and 4) Validation. See Figure 3 below for an overview. This is not to suggest this is the only design process that can be used, but is rather an appropriate starting point given the observed overlap in design process models.

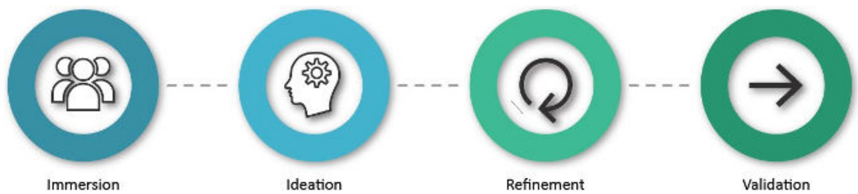

Figure 3. A 4-phase design process model based on significant overlap identified in existing design process models and industry practices.

5. PHASE OBJECTIVES

Before mapping goal and need types to the design process, it is important to clarify the objectives of each of the four phases outlined above. Briefly, *immersion* focuses on developing a deep understanding of the problem space to be explored (Design Council, 2019). The primary objectives of immersion include: defining groups of people with similar goals and/or aspirations, understanding the contextual situation (time and place) in which goal-directed activities take place, and identifying high level objectives regardless of existing solutions. As Stickdorn, et al. suggests (2018, p. 85), immersion is intended to "make sure you are solving the right problem before solving the problem right."

Ideation, on the other hand, focuses on developing a wide range of ideas, both conceptually, digitally, and physically (e.g., prototypes), to meet the aspirational goals identified through immersion. Importantly, ideation is also the phase in which the team must identify all the tasks, activities, and behaviors that people currently participate in to achieve their goals. Often, this takes place in the form of ethnographic research, market research, and/or competitive audits to understand the current ways in which people accomplish higher level goals. The conceptual design direction should be largely identified by the end of the ideation phase.

Refinement involves the detailed design work required to realize the conceptual design solution. The refinement phase is inherently iterative, with multiple rounds of prototyping and testing to ensure prospective users can effectively interact with the design solution to achieve both their task-based and aspirational-oriented goals.

Finally, *validation* requires testing the designed solution to ensure it has met the aspirational goals (*be-goals*), preferred approach for achieving those goals (*do-goals*), and basic psychological and physiological goals (*motor-goals*) defined during earlier phases of work. True validation often occurs only after the product has been made available for use (e.g., 'on the market').

6. TOWARDS A HOLISTIC DESIGN PROCESS

As McCarthy and Wright (2004) suggest, one's thoughts, ideas, emotions, body, and context are inseparable, complex, and inextricable. Similarly, the interplay between sensation, emotion, intellect, and action are 'situated' in a particular place and time (Overbeke, Djajadiningrat, Hummels, Wensveen, 2002). Together, these facets of our situated reality determine our experience with interactive systems. A starting point for developing a more holistic design approach would be to consider the categorical distinction of users' goals, and the requisite needs to fulfill these goals, throughout the design process. See Figure 4 below, which outlines a framework for integrating needs, categorized by goal-type, throughout a 4-phase design process.

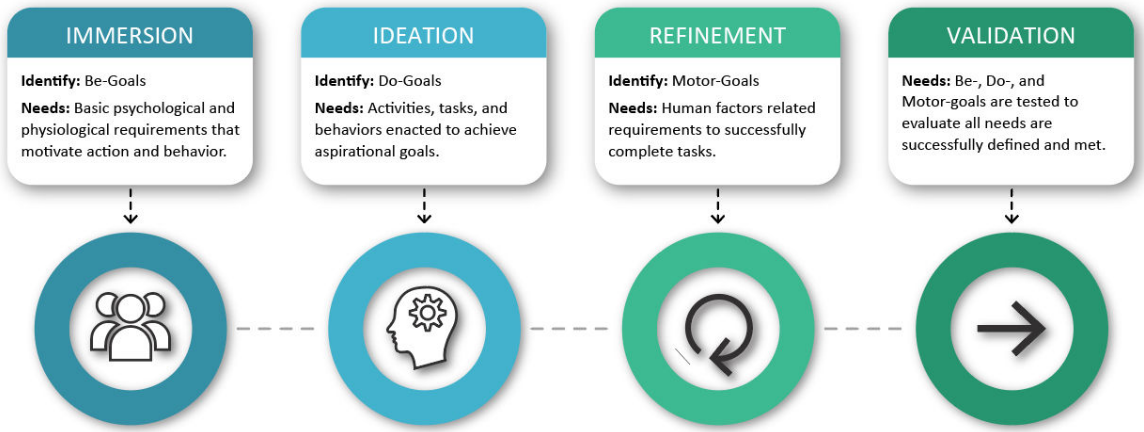

Figure 4. A 4-phase design process model with inputs derived from Carver and Scheier's 3-level hierarchy of goals.

Immersion. From a practical perspective, there is value in focusing on specific types of goals and needs at individual phases of the design process as it helps the design team identify clear questions, objectives, and, as discussed later, methods to achieve those objectives. During the immersion phase the design team can focus on high level *be-goals* in order to understand the aspirational goals people are trying to accomplish, regardless of the techno-socio solutions available on the market today. To use a medical example, an orthopedic surgeon might aspire to become the most effective and highly skilled ACL surgeon available to support star athletes. To use a more everyday example, one might aspire to be viewed as a caring leader who regularly contributes to the positive growth of a local community. It is helpful for design teams to understand what motivates people to behave or act before deciding on a particular solution space to pursue. Defining the primary motivations, or *be-goals*, can help provide focus by narrowing the field of possible solution spaces to explore. It would be highly unproductive to consider *motor-goals* at this point in the process, as there is no solution to evaluate.

Ideation. The activities, actions, and behaviors people engage in to accomplish aspirational goals are, of course, highly varied. To use the previous example of the orthopedic surgeon, one surgeon might decide to learn the most advanced technical solution on the market while another surgeon might work closely with a medical device start-up to develop a completely novel solution for future ACL repairs. The aspirational goal is largely the same (e.g., to provide the safest and most effective ACL repair solution to patients), but the way in which they have chosen to achieve this goal is quite different. The ideation phase, therefore, encompasses both developing an understanding of existing solutions on the market and a process for deciding on a particular direction (solution space) to enable one's aspirational goals. The ideation phase, therefore, focuses on understanding *do-goals*, which is to say its core objective is to understand *how* an individual would prefer to accomplish his or her aspirational goals. In doing so, the team can decide on the general solution space or product category to pursue or, alternately, develop a completely novel approach to serving one's aspirational goals. *Do-goals* can be evaluated through early conceptual visions (non-functional prototypes, storyboards, etc.) to ensure the fundamental idea advances the prospective user's goals in compelling and meaningful ways. Importantly, the conceptual vision for the product, service, or system, should be largely defined by the end of the ideation phase.

Refinement. With the conceptual solution largely defined, design teams can turn their focus towards more detailed concept development during the refinement phase, evaluating functional and interactive concepts to ensure they enable people to successfully accomplish the tasks and activities they engage in to accomplish their goals, and do so in a safe, efficient, and effective manner. In Refinement, the focus largely shifts to *motor-goals* and the fundamental human factors related needs required to achieve these goals. Evaluation of *motor-goals* can be conducted through human factors engineering methods, such as usability testing. *Motor-goals* are strategically important for design teams, as they provide a clear link to defining product requirements (e.g., button sizes, display contrast requirements, size and weight requirements, etc.). *Motor-goals* can be objectively tested or measured for evaluating success.

Validation. Finally, validation occurs as the product development life cycle nears completion, and is often not fully validated (or invalidated) until the product is made available to the general public. Validation encompasses evaluation of all 3 levels of goals, including *be-*, *do-*, and *motor-goals*, as well as the associated needs. In practice, the design process is cyclical, as products are continuously re-evaluated, re-designed, and re-deployed in the market.

7. DISCUSSION

Categorizing needs according to a 3-level hierarchy of goals provides a novel yet practical framework for integrating need identification throughout the design process. The implications have been described on a macro-level, aiding in the definition of the *solution space* versus the *problem space*, as well as a micro-level, providing guidance for considering goals and needs throughout a 4-phase design process model. The inextricable relationship between needs and goals has also made clear that, despite often cited definitions of need, the solution space often defines the needs. This is certainly the case when needs are categorized according to *do-* and *motor-goals*. The mapping of needs identification to an established design process model also provides important implications for practicing design professionals. By focusing on specific goal-types during individual phases of development, design teams can better develop more focused research questions, clarify process objectives, and select appropriate research activities for each phase of the design process. Further research into selecting specific research methods for each phase described in this model is clearly warranted.

There are, of course, limitations to this model. Unforeseen challenges arise in everyday corporate environments that might quickly limit a team's ability to 'stay the course,' and carry out the model from start to finish to realize its full potential. As Iversen, Kunø, & Vistisen (2018) have shown, many design-led corporations and consultancies do not regularly adhere to best design processes, as factors ranging from management preferences and internal deadlines, amongst others, often play a role in how design processes are managed. In addition, it remains to be seen if the mapping advocated here provides sufficient flexibility for the wide range of disciplines, domains, and problem types designers face today. Further research into these areas will, no doubt, affect the design process model and methods for integrating need identification throughout the development process.

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