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## *Being a professional: Three lenses into design thinking, acting, and being*

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*This paper presents three lenses for interpreting design thinking: a framework on learning to become professionals, and two interpretations of this framework that speak broadly to aspects of 'design thinking'. The first lens draws on a framework for 'an embodied understanding of professional practice' and provides a way to describe how professionals form and organize their knowledge and skills into a particular 'professional-way-of-being'. The second and third lenses provide examples of using this framework to interpret existing results from phenomenographic studies on ways of experiencing design and ways of experiencing cross-disciplinary practice. We conclude with a discussion of how these three lenses contribute to a working synthesis of design thinking and learning.*

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*Keywords: design cognition, design practice, interdisciplinarity, teamwork, phenomenography*

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The idea of 'design thinking' has typically represented what designers understand about design and how they go about the act of designing based on this understanding. Within this space of design thinking and acting are a complex set of interacting ideas that include 'designerly ways of knowing' such as tackling ill-defined problems and following a solution-focused mode of problem solving (Cross, 2006), ambidextrous mindsets for innovation (Lande & Leifer, 2010), features of design such as design as learning or design as a mixture of creativity and analysis, types of design thinking such as situation-based and strategy-based approaches, and forms of design activity such as formulating, moving, evaluating, and managing (Lawson & Dorst, 2009). Design is also a social process (Bucciarelli, 1996) that involves thinking and working across different perspectives and often involves considerable conflict and negotiation. Looking across these

[www.elsevier.com/locate/destud](http://www.elsevier.com/locate/destud)  
0142-694X \$ - see front matter *Design Studies* 32 (2011) 588–607  
doi:10.1016/j.destud.2011.07.004  
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descriptions it is not difficult to imagine how design thinking may be evident in or shared across diverse professions, or be influenced by working with people with different perspectives on complex cross-disciplinary problems.

While unpacking 'design thinking' is important, a greater challenge is creating or finding frameworks to guide a 'working synthesis' (Cross, 2010) for understanding what it means to be a design professional (e.g., knowledge, skills, and skillful performance), how designers become professionals (e.g., learning progressions (Duncan & Hmelo-Silver, 2009)), and how educational programs should help prepare aspiring professionals for the challenges of professional practice. Such a framework needs to speak to multiple dimensions of learning, not just knowledge and skill progression but how learning to become a designer involves 'working in a different way' such as different ways of looking at problematic situations, and provide insight into puzzling complexities such as how designers can simultaneously display the behavior of a novice in some parts of design work, while also displaying behaviors that are more characteristic of higher levels of expertise (Lawson & Dorst, 2009, p. 92). Such a framework should also push us to challenge old assumptions and connect to new perspectives. For example, Lawson and Dorst (2009) question if there is something fundamentally more to design learning than just skill acquisition:

'the quotes of the most experienced designers in this book suggest they are their practices...most designers seem to feel easier describing themselves through the projects that, taken together, make up their practice...designing is not just something you do, or that you take lightly when you practice it, but rather it helps form your identity...design becomes a part of one's being because it involves so much that is personal, like your creativity, way of approaching the world's problems, your own history, learning style and view of the world (Lawson & Dorst, 2009, pp 270).'

One framework that accomplishes these goals, maps an interconnected space of knowing, acting, and being professionals, and illustrates the ways variations within this space open multiple trajectories for becoming professionals (Dall'Alba, 2009a, 2009b; Dall'Alba & Sandberg, 2006). Here, knowledge and skills are still central to learning and professional practice, but they are embedded within an embodied understanding of practice. More specifically, not only do professionals learn knowledge and skills, 'but these are renewed over time while becoming integrated into ways of being the professional in question' (Dall'Alba & Sandberg, 2006, p. 389).

The purpose of this paper is to present Dall'Alba's (2009a) framework and to explore its use for informing a working synthesis for 'interpreting design thinking' through two phenomenographic studies. One study asks 'how is design experienced and understood across domains' and the interpretation within this framework illustrates ways of design thinking, acting, and being shared across domains of design practice (Daly, 2008; Daly et al., in press). The other

asks, 'how are collaborative cross-disciplinary situations experienced and understood within engineering contexts' and the interpretation illustrates ways of cross-disciplinary thinking, acting, and being within engineering contexts (Adams, Forin et al., 2009, 2010). Together these studies provide insights into how design is experienced across disciplines and within cross-disciplinary collaborations. In the following sections we present these three lenses and discuss how a framework of 'becoming professionals' may guide the development of a working synthesis for interpreting design thinking.

## *I Becoming professionals*

'Learning to become a professional involves not only what we know and can do, but also who we are (becoming). It involves the integration of knowing, acting, and being in the form of professional ways of being that unfold over time' (Dall'Alba 2009b, p. 34)

The process of becoming professionals is always open-ended and incomplete. It entails developing and refining an embodied understanding of professional practice that integrates knowing, acting, and being in the world (Dall'Alba, 2009a). This embodied understanding is not limited to individual cognition, then, but is embedded and enacted within the dynamic, intersubjective flow of activity that is professional practice. This unfolding professional way of being incorporates not only our knowing and how we act, but also who we are as professionals. It gives meaning to the knowledge and skills being developed within professional practice, while also incorporating an understanding of the practice itself. As such, the space of learning in this framework: (1) integrates epistemological and ontological dimensions of thinking, acting and being, and (2) overcomes a separation of 'mind' from body, in the form of embodied understanding of practice.

In this framework, development is not a stepwise process of moving through a fixed sequence of stages (see for example Dreyfus & Dreyfus, 2005), but includes both continuity and change as an understanding of practice develops. As professionals learn to deal with new situations, their embodied understanding of practice evolves in qualitatively different ways. These learning progressions may lead to more comprehensive understandings of practice or they may involve refinement of an existing understanding of practice. When multiple development trajectories open as possibilities in this way, we press ahead into shaping and forming our own development within, or sometimes despite, the existing constraints. 'As our activities and projects shape our becoming, we are likely to take up those opportunities that are consistent with or advance our sense of self, while resisting those that undermine our sense of who we are (Dall'Alba, 2009a, p. 55).' In this way, the unfolding of professional ways of being has many possible trajectories — there is no single path towards becoming a professional, no unidirectional trajectory from novice to professional. Encountering these multiple trajectories as possibilities can open us to

rethinking assumptions, challenging constraints, and renewing practice. This process can be both energizing and unsettling – challenging us in what we know, how we act, and who we intend to be.

### *1.1 An alternative to existing frameworks*

It is important to note that this framework is an explicit effort to overcome two major limitations of some existing theories of learning and approaches to curriculum design (Dall'Alba, 2009a). The first limitation is a separation of knowing (epistemology) from being (ontology), which is overcome by recognizing that knowing is enacted and embodied in and through our everyday practice as professionals. Current theories of learning and approaches to curriculum typically emphasize the epistemological dimensions and neglect the ontological dimensions of learning. This carries a risk of reinforcing a static, fixed view of expertise, rather than acknowledging variability in ways of experiencing and enacting practice and the associated potential of this variation for renewal of practice. A related risk is a focus on technical mastery, which can encourage narrow conceptualizations of what practice entails. In contrast, embracing variation and ambiguities in learning enable us to recognize that becoming professionals is always open-ended and incomplete. Similarly, ignoring the role of identity in learning has been associated with: challenges in transferring learning across contexts; restricting the identities aspiring professionals are invited to construct; and an inability to meet the demands of continuously shifting and interacting bodies of knowledge (Nasir, Stevens & Kaplan, 2010). In Dall'Alba's alternative framework, practice is seen as dynamic and complex, routinized as well as creative, not singular but pluralistic. The same practice is enacted and embodied in qualitatively different ways and has several meanings, just as everything we live or think has multiple meanings.

The second limitation this alternative framework seeks to overcome is a separation of mind, body, and world. A central idea in this framework is embodiment as a condition for knowing – that the lived body provides access to the world and makes knowing possible. Due to the situatedness of the lived body, we always adopt a perspective on our world and in what we come to know. This situatedness and the ambiguities inherent in relating to our world mean we are challenged to live with pluralism and paradox as we engage in professional practice. Dall'Alba (2009a) argues that current theories of learning typically emphasize cognition and the mind, rather than embodiment of mind and self. A consequence of seeing mind, body and world as separate entities is that the significance of our entwinement with the world of practice is overlooked.

### *1.2 Investigating ways of experiencing practice*

Phenomenographic techniques are well suited for investigating how people experience professional practice. As such, interpreting existing phenomenographic studies through an 'embodied understanding of practice' framework

is consistent with the underlying mode of inquiry. Phenomenography is an empirically derived research approach that is used to capture variations in understanding an aspect of the world, while revealing the critical components that comprise those variations (Bowden, 2000; Marton & Booth, 1997). With respect to mapping an understanding of professional practice, 'in any one social, historical, and cultural context, there are likely to be a limited number of qualitatively different ways in which a particular practice is understood and carried out' (Dall'Alba & Sandberg, 2006, p. 400). These differing ways of being professionals are logically related to each other, as they are based on the same practice.

In phenomenography, participant selection is informed by a strategic effort to maximize diversity in participants' experiences to enable an inclusive view within the aims of the study (Akerlind, 2005). Data collection often follows a semi-structured interview protocol (e.g., questions about experiences and the meanings associated with those experiences) to provide deep, reflective, and contextualized data within these experiences (see Mann et al, 2007; Daly, 2009). Data analysis involves iteratively reading *whole* transcripts and sorting them into distinct ways of experiencing or understanding an aspect of the world. This process enables critical variations within a landscape of awareness to be revealed and distinguished. Finally, relationships between these distinctly different ways of understanding are explored and described. Overall, the analysis is a rigorous iterative process of being disciplined by the data, looking for empirical evidence of patterns, and seeking logical arguments in how patterns relate.

In the following sections we summarize results from two phenomenographic studies that speak broadly to the topic of 'design thinking' and interpret these results through a framework of thinking, acting, and being professionals. For both studies, the goal was to map out a landscape of awareness – the breadth of qualitatively different ways people experience, give meaning to, and interact with 'design' or 'cross-disciplinarity' – and to describe the relationships among these distinct ways of experiencing. These studies are not intended to be definitive of design expertise. Instead, they focus on ways of experiencing design, on the one hand, and of cross-disciplinary practice in engineering, on the other. Additional research is needed to explore the extent to which the results of these studies have broader applicability, as well as how they relate to embodied practice of professionals.

## *2 Ways of experiencing 'design' practice across disciplines*

Daly (2008, 2009) and Daly et al. (2008, in press) investigated the ways design has been experienced by professionals within and outside engineering fields to better understand what it means to design and be a designer. By focusing on how professional designers experience design, the study made visible how

professionals give meaning to, and approach design – filling a theory gap in linking ‘how’ professionals design with ‘what’ they come to understand about design. By exploring design experiences across disciplines, the study sought to reveal patterns of experience that hold design together as a domain unto itself (see Blackwell et al., 2009; Cross, 2006; Zimring & Craig, 2001) as well as important variations in design thinking that may have consequences for when designers with different training collaborate on design projects. In collaborative design projects that involve multiple disciplines or stakeholder perspectives, designers may not have the same meanings for design, and assumptions about shared meanings may adversely impact project processes and outcomes.

Twenty professional designers were recruited based on diversity in years of experience, gender and, most importantly, disciplinary training or association. Diversity in technical design area focused on two dimensions relevant to engineering contexts: within engineering disciplines (e.g., sub-disciplines of engineering including mechanical, civil, biomedical, and chemical) and across design-related disciplines (e.g., architecture, applied chemistry and physics, dance composition, painting and writing, experience design and computer science, instructional design, culinary arts, and fashion design). Goel and Pirolli's (1992) framework on invariant features of design task environments was used to justify recruitment across disciplines based on the likelihood of finding design professionals in that discipline.

Table 1 summarizes the six qualitatively distinct and hierarchically related ways of experiencing design that emerged from this study based on the specific experiences of the diverse set of designers (see Daly, 2008; 2009). The self-identified disciplines of the designers should not be generalized as to how any designer in that discipline would experience design. Going from least comprehensive to most comprehensive, the categories of description include design as (1) evidence-based decision-making, (2) organized translation, (3) personal synthesis, (4) intentional progression, (5) directed creative exploration, and (6) freedom. These categories of description do not represent a taxonomy or fixed stepwise learning progression; rather, they represent situated meanings designers associated with their work (ways of thinking), impacting the way they approach design tasks (ways of acting) and understand themselves as designers (ways of being). As such, we make no claim that development proceeds stepwise from category 1 to category 6 in Table 1. We anticipate that a single development trajectory is unlikely, but rather that many trajectories will be possible (Beaty, Dall'Alba & Marton, 1997; Dall'Alba, 2004; Dall'Alba, 2009a); however further empirical research would be necessary to substantiate this conjecture.

As shown in Table 1, results did not strictly follow disciplinary distinctions. In contrast, the experiences and understandings represented in this study appear to be shared across multiple disciplinary perspectives. General trends in the

**Table 1** Categories of description for ways of experiencing design across disciplines (disciplines self-identified by participant)

<i>Category of Description</i>	<i>Designers' Experience in this Category</i>
Category 1: Evidence-Based Decision-Making	Duncan (Chemistry) Evelyn (Civil Engineering)
Category 2: Organized Translation	Charlotte (Chemical Engineering) Glenda (Dance Composition) Leann (Mechanical Engineering) Parker (Civil Engineering)
Category 3: Personal Synthesis	Hannah (Fashion Design) Netty (Instructional Design) Omar (Culinary Arts) Quentin (Chemistry & Educational Research) Roberta (Chemical Engineering)
Category 4: Intentional Progression	Alan (Architecture) Fritz (Computer Science) Isaac (Mechanical Engineering) Ken (Physics)
Category 5: Directed Creative Exploration	Bill (Biomedical Engineering) Svenson (Chemical Engineering) Tyson (Analytical Chemistry)
Category 6: Freedom	Jack (Painting and Writing) Marc (Experience Design & Computer Science)

hierarchy relating categories include expansion of context from the immediate problem to a wider consideration beyond the problem, movement from a solution-focused design approach to one that is problem-focused, and a change in agency for who defined the problem and evaluated the design from others to oneself.

### *2.1 Interpretation - ways of design thinking, acting, and being*

In this section we discuss study findings and translate these through the integrated framework of thinking, acting, and being professionals. In particular, critical variations in ways of experiencing design are described in terms of interactions among (1) what professional designers come to understand about the nature of design and design problems (thinking), (2) how professional designers approach design (acting), and (3) how design professionals shape their identity (being).

#### Category 1: Evidence-based decision-making

For this category, design is experienced as evidence-based decision-making to find a best solution for the problem at hand. Critical attributes of ways of experiencing and understanding design for this category include: knowing and investigating multiple solution options and using evidence, data, and resources to make decisions; valuing and maintaining records of design decisions for themselves and others; and a focus on finding the best solution for

the specific design problem presented. This category is distinctive through its focus on logic, evidence, and rationality, which are consistent themes in the design literature (e.g., Lewis et al., 2006; Simon, 1969). The experiences in this category illustrate an awareness of design as solution-focused towards a 'best' solution that is determined based on evidence of how a solution meets externally specified problem requirements. Here, ambiguity is understood as something that can be eliminated by using evidence and researching previous or similar work. Documentation also plays an important role in capturing the history of prior decisions and making a case for current decisions. Designers conveyed their identities as professional designers as logical decision makers, driven by evidence and skillful and consistent problem-solvers. These components represent their professional ways of being.

#### Category 2: Organized translation

This way of experiencing design focused on translating an idea into a product that works in the context of a design task. The word 'translation' captured the way that designers talked about going from an idea or problem to an end goal of a working solution (and not necessarily the best solution). Unique attributes of ways of experiencing and understanding design for this category include: an organized and systematic approach (e.g., creating multiple ideas, trial-and-error experiments, data gathering, evaluation); fluid and iterative approaches; a simultaneous consideration of all of the pieces and players in potential solutions; and producing a working solution to the problem at hand.

Category 2 is distinct from Category 1 (Evidence-Based Decision-Making) by emphasizing a fluid design approach of constant questioning and translating or mapping ideas to plans and outcomes. This is an idea that illustrates an awareness of design as guided by situation specific intentions (e.g., Nelson & Stolterman, 2003; Rowland, 2004). The experiences in this category illustrate an awareness of design as balancing and addressing multiple pieces of a larger whole, recognizing that a 'best' solution is one that works in a given context, and tolerating ambiguity by engaging in iterative cycles of trial-and-error experiments and stakeholder feedback. These understandings are enacted as a process of organized translation – breaking problems into smaller parts, revisiting previous design decisions with new information, and linking activities of conceptualizing a solution with implementing or manufacturing that solution. As such, the way of being for the designer is to be a translator, developing outcomes from multiple pieces, ideas, and perspectives.

#### Category 3: Personal synthesis

For this category, design is experienced as the synthesis of resources through the personal (human) lens of the designer or design team, and as such, the synthesis product will be unique to the people who bring the pieces together. Attributes of ways of experiencing and understanding design for this category include: utilizing multiple resources as a starting point such as previous similar

designs, others' work and ideas, and personal experiences and knowledge; generating design solutions from a combination of resources; building experiences to create each designer's own intuition and repertoire; and work motivated by achievement of the design goal and personal improvement.

The experiences of Category 3 are distinct from Category 2 through an emphasis on the human element of design and how design tasks are interpreted through a personal lens. A focus on synthesis and a need for defining personalized stopping rules are consistent themes in the design literature, particularly in regard to ill-structured 'wicked' design problems (e.g., Cross, 2006; Goel & Pirolli, 1992; Rittel & Webber, 1973). The experiences in this category illustrate an awareness of the value of a personal lens in shaping design problems and building a repertoire, as well as accepting ambiguity as a natural part of design activity. Diverse resources and the designers' own personal experiences are synthesized to shape design outcomes. In this way, design is a continual learning process of building intuition and a personal repertoire, driven by a personal desire to use old ways to imagine new ways of thinking, acting, and being.

#### Category 4: Intentional progression

This way of experiencing design emphasizes the potential for progress a design has through taking a larger context into account. The idea of what progress meant to the designers came in multiple forms such as the design of experiments that could inform larger physics theories, making improvements on previously existing artifacts, and facilitating future expandability of a design. Unique attributes of ways of experiencing and understanding design for this category include: a solution informed by and focused on both the situational context and the context of time, as designs could be a building block for future work and progress; a goal of contributing to resolution of problems outside of the immediate design task space; and an awareness of the continual nature of design, including the lack of an externally defined stopping point.

The experiences of Category 4 are distinct from Category 3 through an emphasis on how the context of design is larger than the immediate project timeline so that goals are aimed at creating better solutions for the present as well as the future. In this way, design is guided by intentional openness to be creative and reflective (see Nelson & Stolterman, 2003; Schön, 1993). The experiences in this category illustrate an awareness and value for ambiguity as a central part of the design experience — that problems are loosely set at the 'start' and iteratively defined. In addition, the goal of creating solutions moves beyond finding the best solution for a specific current use and context to imagining a broader timeline of future needs. These future goals are wrapped into the ways a problem is defined, what kinds of information is gathered to understand to the context, and how solutions are evaluated in terms of present and future impacts. The designers' ways of being involve a 'big-picture' perspective and taking on a role of seeing choices through multiple viewpoints and possible futures.

#### Category 5: Directed creative exploration

For this category, design is experienced as exploration — a fluid strategic and directed path that leaves the designer open to both opportunities and potential failure, but is directed towards an outcome that has value. Unique attributes of ways of experiencing and understanding design for this category include: an effort to investigate ideas that emerge and to experiment with loosely defined endpoints; embracing risks that result from exploration of unknowns; a willingness to try new things and think beyond traditional outcomes; molding the shape of the design task through exploration of emergent opportunities; and the development of an outcome with a value perceived by others (e.g., fulfilling a need, solving a problem, forming new ideas).

The experiences of Category 5 are distinct from Category 4 through an emphasis on being flexible and open to discovering new design paths and outcomes. These discovery approaches are principled, even though there may be opportunistic deviations, and are a form of discovery-guided reflective practice (see Schön, 1993). The experiences in this category illustrate an understanding of how problems exist in an exploration space (Newell & Simon, 1972), that solutions are not 'final' and that ambiguity in design opens up opportunities for new problem and solution spaces. As such, design is practiced as discovery-based investigations that occur at the onset of a task. This enables simultaneously exploring a problem space, pushing on solution boundaries, and redefining problem attributes. This involves being comfortable with improvisation and a willingness to take risks and follow an emergent design path.

#### Category 6: Freedom

This way of experiencing design emphasizes the freedom design tasks allow, due to problem and solution ambiguities. In this way, design tasks offer freedom, and design constraints are perceived as beneficial to that freedom, directing the designer to create within new realms. Here, the boundaries of the design task are a function of the meanings designers associate with the design outcomes. This involves embracing opportunities to create any number of novel outcomes that have meaning or value for others or for themselves. Unique attributes of ways of experiencing and understanding design for this category include: the open-ended and flexible paths offered by design work; welcoming and embracing ambiguity; iteratively defining designers' own boundaries and constraints; and a design outcome guided by a criterion of meaning (e.g., designing new genres and templates, creating foundations that have meaning beyond a single project).

The experiences of Category 6 are distinct from Category 5 through an emphasis on facilitated ambiguity by self-defining flexible design boundaries. These ideas are consistent with a view of designerly ways of knowing as being tolerant and working with ambiguity (e.g., Cross, 2004) and that designers impose order on a design project by redefining the problem through solution conjectures

(e.g., Akin & Lin, 1995). The experiences in this category illustrate an understanding of problem formulation as an iterative process, ambiguity as transformative, and the outcome of design as creating meaning. These ways of thinking are enacted through allowing design possibilities to emerge, flexibly transforming ‘constraints’ into ‘freedoms’, and the co-evolution of problems and solutions. These ways of thinking and acting represent a design mindset – a designer of outcomes – that is used not only in design situations but also as a natural part of everyday life.

Overall, interpreting findings from this study through a framework of thinking, acting, and being a professional illustrates (1) how existing research findings may be mapped to this framework, (2) the process and theoretical significance of linking how people design to what people understand about design and themselves as professionals, and (3) how relationships among qualitatively different variations in an embodied understanding of design practice open up multiple trajectories of interconnected ways of design thinking, acting, and being in the world. An added value of this study to the broader discussion of ‘interpreting design thinking’ is that it directly addresses questions about ways of experiencing and understanding design across multiple disciplines.

### *3 Ways of experiencing ‘cross-disciplinary’ practice in engineering contexts*

For the third perspective, Adams and Mann investigated the ways cross-disciplinary practice in engineering contexts is experienced and understood (see Adams, Forin et al., 2009; Adams et al., 2010). Here, the term *cross-disciplinary* is used to characterize a collection of practices associated with thinking and working across disciplinary boundaries such as multidisciplinary, interdisciplinary, and transdisciplinary (Adams, Mann et al., 2009, chap. 19). Rather than focus on group behaviors and outcomes, the motivation for this study was to make visible what individuals in collaborative cross-disciplinary situations come to know, learn how to do, and identify as cross-disciplinary professionals. This study provides a complementary view to Daly’s study by focusing on the social aspects of collaborating on cross-disciplinary ‘wicked’ projects that involve integrating technical and non-technical considerations, negotiating and reasoning within and across domains, and managing trade-offs involving interdisciplinary criteria (Adams, Forin et al., 2009).

Twenty-two engineers and non-engineers who worked in engineering contexts and had at least one cross-disciplinary experience were strategically recruited to establish an inclusive outcome space. Key recruitment goals were to maximize diversity in terms of the complexity of the projects participants experienced and the extent to which participants interacted with others who had similar (i.e., engineers working with other kinds of engineers) or different epistemological perspectives (i.e., engineers working with a social scientist or artist). Other

variations in the sample included the context of work (academia, private industry, and community service), years of cross-disciplinary experience, and gender.

Four qualitatively distinct and hierarchically related ways of experiencing cross-disciplinary practice in engineering contexts emerged from the data (see Adams, Forin et al., 2009; Adams et al., 2010). Going from least comprehensive to most comprehensive, ways of experiencing and understanding cross-disciplinary practice include: (1) working together to produce a better outcome, (2) intentional learning so all gain (me, my team, my stakeholders), (3) strategic leadership to enable synergy and innovation, and (4) challenging and transforming practice to integrate systems. As stated in the prior section, these categories, while hierarchically related, do not represent a fixed stepwise developmental trajectory but rather a space of multiple trajectories of interconnected ways of cross-disciplinary thinking, acting, and being in the world.

### *3.1 Interpretation - ways of cross-disciplinary thinking, acting, and being*

In this section we discuss study findings and interpret these through Dall'Alba's embodied understanding of practice framework. In particular, critical variations in ways of experiencing cross-disciplinary practice in engineering contexts are described in terms of (1) thinking (awareness of 'difference', situation complexity, and goal direction), (2) acting (approaches for engaging with 'difference' and situation complexity), and (3) being (self-perceived role or identity in cross-disciplinary situations).

#### Category 1: Working together

The experiences in Category 1 illustrate cross-disciplinary practice as working together with people who have different training to effectively find a better solution. Critical attributes of ways of experiencing and understanding cross-disciplinary practice for this category include: an iterative process of asking questions, challenging assumptions, and listening for understanding; being comfortable with asking for information that might seem obvious to an expert in that domain; knowing what you and others contribute; recognizing differences in what people know and how they communicate; and the need to take personal responsibility to be an effective collaborator. Category 1 is distinctive because of a focus on the experience of collaborating and communicating with people who have different perspectives, language, interaction styles, and ways of thinking. This appears to be a foundational category since the other categories build off of these ideas in increasingly complex ways.

As such, ways of thinking involve an awareness of differences in disciplinary training and how these differences complicate the process of working together towards an effective outcome. This awareness drives an iterative communication process of asking questions and listening for understanding with those who are perceived as relevant for determining what is desired or feasible within

a bounded application space such as meeting a specific client's needs or extending an existing application to a new context. In this way, different perspectives are seen as a 'value-added' information source. This approach involves taking individual responsibility for being an effective collaborator and providing disciplinary expertise on solution feasibility and desirability.

#### Category 2: Intentional learning

The experiences in this category emphasize cross-disciplinary practice as an intentional learning process so that everyone gains (me, my team, and my stakeholders). A predominant feature of these experiences is a passion and appreciation for learning that drives self-directed learning practices. Unique attributes of ways of experiencing and understanding cross-disciplinary practice for this category include: creating opportunities to learn new perspectives or ways of knowing; purposefully educating each other to collectively enable a systems perspective; learning through experience and failure; learning how to negotiate meanings across perspectives and formulate or investigate problems through multiple lenses; and a passion and appreciation for continual learning.

Category 2 emphasizes the process and outcomes of collaborative and situational learning. This category builds on Category 1 (Working Together) because it represents a process of improving the conditions needed to work together with people with different training to address complex problems of social and global significance. Here, a focus on cooperation and collaboration expands to include social learning, a focus on complex problems expands to include social and global elements, and a role evolves from being a collaborator to being a self-directed learner. More specifically, an awareness of differences changes from recognizing disciplinary differences to respecting the difficulty of disciplinary training and learning at the intersection of differences. Creating opportunities to address complex challenges emerges through intentional learning experiences that involve immersion in other disciplinary ways, seeing failure through an opportunistic mindset and having a passion for discovering alternative ways of seeing the world.

#### Category 3: Strategic leadership

The experiences that represent Category 3 focus on applying prior learning to actively enable cross-disciplinary work and outcomes. In other words, cross-disciplinary practice is strategic leadership to enable cross-disciplinary work and synergy for the best outcome. Leadership is central in that it involves being the 'interface', 'connector', or 'communication specialist' to cross disciplines, organizational structures, and cultures to proactively create an environment for innovation. Unique attributes of ways of experiencing and understanding cross-disciplinary practice for this category include: making or enabling conceptual connections; building allegiances and trust; and facilitating systems-oriented strategies or frameworks that leverage diverse

perspectives. Some strategies involve actively transforming a negative working environment into a positive one.

Category 3 is distinct from Category 2 (Intentional Learning) by emphasizing proactive approaches for successful cross-disciplinary discovery and innovation through managing and leveraging differences. 'Orchestrating' is explicitly emphasized through a self-identified role of being a facilitator at the cross-disciplinary interface and taking the risk of leading projects towards shared and valued outcomes. This is a leadership role directed at facilitating synergy and enabling the team rather than promoting individual egos. As such, the experiences of Category 3 build off of Category 2 by applying prior learning from the challenges and affordances of cross-disciplinary experiences to proactively enable new insights. This is situated in an awareness of how cross-disciplinary work can break down: differences in perspectives and values across disciplinary, organizational, and cultural perspectives; single perspective problem formulations that lead to ineffective and inappropriate solutions; an inability of disciplinary paradigms to meet complex economic and political needs; and a need to engage a social network of expertise. Like Category 1 (Working Together), elements of collaboration and successful outcomes are evident in Category 3; however, an awareness and understanding of what enables success expands to include issues of trust, respect, shared ownership, and inclusivity such that disciplinary, organizational, and cultural perspectives can be synergistic and open up new ways of thinking.

**Category 4: Challenging and transforming practice to integrate systems**  
For this category, cross-disciplinary practice is experienced as challenging and transforming practice to integrate systems and produce an outcome greater than the sum of its parts. This transformative reflective practice involves challenging prior training and beliefs about what counts as 'good practice', attributes of good solutions with respect to stakeholder risks, and how organizational cultures support or inhibit professional growth and social justice. Unique attributes of ways of experiencing and understanding design for this category include: critically challenging disciplinary practice and investing in the ways conflict can be transformative; integrating stakeholders as collaborators; attuning to the human aspect of complex systems; advocating less visible perspectives by taking into account the broader context; and embracing cross-disciplinarity as an everyday practice.

The experiences of Category 4 are distinct by focusing on a process of questioning practices and boundaries. Where Category 3 (Strategic Leadership) involves leading teams in creating common ground and new ways of thinking, a leadership role for Category 4 expands to include being a transformative agent as well as being transformed; where Category 3 focuses on enabling cross-disciplinary discovery and innovation, Category 4 is about critical

reflective practice to enable transformative learning and outcomes (for individuals, teams, stakeholders, and disciplinary practices). Category 4 involves expanding an awareness of ‘difference’ to include lived experiences and recognizing how boundaries between differences are socially constructed. This awareness facilitates critical analysis of the idea of ‘difference’ and a critical exploration into similarities across different perspectives, which leads to new inclusive practices, theories, and identities. As such, the essence of Category 4 is challenging epistemic frames (Shaffer et al., 2009) comprised of skills, knowledge, values, identity, and theories of knowledge, as well as honoring differences in perspective and using diversity and conflict to transform thinking and transcend boundaries. Part of this is attuning to the human and contextual aspects of complex problems through participatory strategies that engage diverse stakeholders as partners, not just information resources. When human and contextual factors are integrated into the system, the limits of prior assumptions about ‘good practice’ or ‘good science’ are revealed and enable new ways of thinking about system performance. For Category 4 there is a unique and explicit identity of ‘being cross-disciplinary’. This new identity may incur experiences of disrespect within and exclusion from prior disciplinary communities as well as seeking out new revolutionary ‘homes’.

Overall, interpreting findings from this study through a framework of thinking, acting, and being a professional further illustrates the frameworks’s utility, applicability, and theoretical significance for supporting a working synthesis of ‘interpreting design thinking’. Whereas Daly’s study maps a space of the ways professionals experience and understand design across multiple disciplines, this study maps a complementary space of some of the social and transformational aspects of designing with others across multiple disciplines in engineering contexts.

#### *4 Discussion*

The three lenses presented in this paper open up a conversation space for conceptualizing a ‘working synthesis’ of design thinking (Cross, 2010) with the potential to renew an integrated understanding of what it means to be a design professional, how designers become professionals, and how educational programs should help prepare aspiring design professionals for the challenges of practice.

The lens of ‘becoming professionals’ provides a theory-based framework for supporting a working synthesis of design thinking by identifying dimensions of an inclusive space of qualitatively different ways of thinking, acting, and being professionals, and multiple developmental trajectories within this space. These dimensions integrate epistemological and ontological aspects of an embodied understanding of practice that embraces the ambiguities of learning to become professionals. The existence of multiple trajectories within this space promotes conversations about the open-ended process of becoming

design professionals and provides opportunities for challenging prior assumptions and renewing design practice. In particular, this perspective challenges prior frameworks that narrowly conceptualize dimensions of design learning by not including the ways in which designers 'are their practices' (Lawson & Dorst, 2009). It also challenges static, stepwise, and fixed models of learning progressions in favor of dynamic and interconnected models that articulate how variations in an embodied understanding of practice reveal multiple trajectories of interconnected ways of thinking, acting, and being in the world.

The remaining two lenses illustrate ways to conceptualize design and cross-disciplinary thinking within this framework by interpreting the results of two phenomenographic studies in terms of ways of thinking, acting, and being professionals. These studies represent a first step towards naming interconnected dimensions of being and becoming a professional. The first study summarizes qualitatively different ways of experiencing design across disciplines that speaks to attributes of design practice that may be shared across disciplines. Going from least comprehensive to most comprehensive understandings, the categories of description include design as (1) evidence-based decision-making, (2) organized translation, (3) personal synthesis, (4) intentional progression, (5) directed creative exploration, and (6) freedom. Critical variations across these categories were interpreted through the 'embodied understanding of practice' framework as interactions among (a) what professional designers come to understand about the nature of design and design problems (thinking), (b) how professional designers approach design (acting), and (c) how design professionals perceive a design identity (being).

The second study summarizes qualitatively different ways of experiencing cross-disciplinary practice in engineering contexts that speaks to the social aspects of designing across disciplines. The categories of variation include (from least to most comprehensive): (1) working together to produce a better outcome, (2) intentional learning so all gain (me, my team, my stakeholders), (3) strategic leadership to enable synergy and innovation, and (4) challenging and transforming practice to integrate systems. Critical variations across these categories were interpreted in terms of interactions among (a) awareness of 'difference', situation complexity, and goal direction (thinking), (b) approaches for engaging with 'difference' and situation complexity as well as meeting goals (acting), and (c) self-perceived role or identity in a cross-disciplinary collaboration (being).

A working synthesis for 'interpreting design thinking' should not only speak to what it means to be and become a design professional, but also what it means to prepare aspiring design professionals and renew professional design practice. When we take seriously the ontological dimension of professional education and the ambiguities of learning to become professionals, professional education can no longer stop short at developing knowledge and skills. A

focus on acquisition of knowledge and skills is insufficient for embodying and enacting skillful professional practice, including the process of becoming that learning such practice entails (Dall'Alba, 2009b, p. 42).

‘Learning to become professionals entails integrating what aspiring professionals know and can do with who they are (becoming), including the challenges, risk, commitment and resistance that are involved.’ (Dall'Alba, 2009b, p. 43)

How do our current educational programs prepare aspiring professionals for an increasingly complex world of practice, and how could educational programs support integration of ways of thinking, acting, and being? For Nasir, Stevens and Kaplan (2010) one answer is to place identity as a core part of the educational process. For teachers this means creating constructive exploration spaces that are authentic, use diversity and variation as a resource, embrace community and social interaction, and allow learners of all ages to become self-authors in ways that integrate epistemological, interpersonal, and intrapersonal dimensions of learning (Kegan, 1994, 2000; Baxter Magolda & King, 2004).

For Gloria Dall'Alba (2009a) one answer is to encourage ‘letting learn’ in developing a capacity for attuned responsiveness, creating space and opportunity for variations in learning, and designing curricula to be open to inquiry where learners have agency to explore different ways of thinking, acting, and being. This latter approach does not imply that ‘anything goes’ in the sense that learning and development in any form or direction is to be encouraged. Rather, it explicitly recognizes that aspiring professionals bring with them varied experiences and understandings, which contribute to forming and shaping what and how they learn. The challenge is to harness this range of experiences and understandings in promoting a capacity to respond in ways that are attuned to the features of each situation encountered in professional practice.

## 5 *Concluding remarks*

The purpose of this paper was to respond to two challenges: (1) the lack of a working synthesis for understanding what it means to be a design professional, how designers become professionals, and what it means to prepare aspiring design professionals, and (2) a need for interpretive frameworks for design thinking that can speak within and across disciplinary perspectives. We addressed these challenges by presenting three lenses, or frameworks, for interpreting ‘design thinking’: a theoretical framework on professional development and two studies that conceptualize aspects of design thinking through this framework.

The first lens presents an ‘embodied understanding of practice’ framework that challenges prior assumptions about learning and opens up a renewal of what it means to be (and become) a professional. This is a praxis-oriented framework because it links a theory of knowledge (what it means to be

a professional) and a theory of learning (multiple trajectories for becoming a professional) to the practice of instruction (ways to prepare aspiring professionals). Because this framework is not unique to a particular profession, it may be used for investigating and articulating what it means to be and become a design professional from both domain general and domain specific perspectives. The second and third lenses illustrate ways to use this framework to guide the development of a working synthesis for both interpreting prior empirical work and designing new studies on design thinking, acting, and being. A unique benefit of the two studies used in this paper is that they are inclusive of many disciplinary perspectives – in particular, how design is experienced and understood across disciplines and how collaborative cross-disciplinary experiences are understood in engineering contexts.

Together these three lenses suggest a roadmap for beginning the process of mapping an inclusive landscape of design knowing and being that speaks across disciplinary perspectives and cross-disciplinary collaborations, integrates epistemological and ontological dimensions of being a design professional, and articulates a language and set of relationships for how variations in an embodied understanding of design practice open up multiple trajectories of ways of thinking, acting, and being in the world.

### *Acknowledgements*

The authors would like to thank our participants for sharing their experiences. We would also like to thank Tiago Forin and Saranya Srinivasan for their input on characterizing ways of thinking, acting, and being. Aspects of this work were supported by a National Science Foundation grant (EEP-0748005).

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