Situated Design-Thinking in Architectural Practice
Analyzing and Extending Schön’s Epistemology

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Abstract

Nearly thirty-five years ago Donald Schön proposed an epistemology of design practice as an antidote to the crisis of legitimacy in architecture and other professional design disciplines. His theory of reflective practice is popular in teacher and nursing education programs and ‘design-thinking’ has gained credibility to promote innovation in business. Yet he failed to provide the epistemic credibility for architectural practice he promised. This critical analysis compares constructs in Schön’s theory against knowledge from mind and brain science to assess their validity and limitations. Findings inform suggestions for extending his theory toward developing a more complete epistemology of architectural practice.
1. Introduction

The 1980’s saw emergence of a new research stream: empirical study of design cognition as a way-of-knowing distinct from science or humanities (Cross, 2007). Central to this effort was Donald Schön’s (1983), *The Reflective Practitioner*, which challenged Simon’s (1996 [1969]) “Technical Rationality” suggesting design be made more rigorous “by the application of scientific theory and method” (ivi, p. 21). Through ethnographic study of architects (and also engineers, town planners, managers, and psychotherapists), Schön described physically and socially situated processes of design-thinking1. He focused attention to *lived experiences* of professionals *in-action* solving ill-defined problems – illuminating tacit knowledge and *artistry* (improvisation) in their practices. Importantly, Schön positioned design-thinking as expertise acquired through practice and worthy of empirical examination.

Today benefits of design-thinking to drive organizational innovation are embraced by corporations (Johansson-Sköldberg *et al.*, 2013), yet architects continue to suffer inability to sufficiently communicate their legitimacy and worth (Cohen *et al.*, 2005). This is due, in part, to the growing complexity of architectural practice – where buildings contribute to the larger environmental and socio-cultural ecosystem – and challenges architects face in explaining or quantifying their intuitive design processes for clients (Cohen *et al.*, 2005; Schön, 1983, pp. 3-20). Given demands for increased rigor in architectural practice to improve building outcomes, the value of design as a discipline continues to be called into question. Architects implicitly understand and appreciate advantages of design-erly over other ways of knowing, but benefits are not always salient to clients and users. Despite decades of design cognition research, architecture still lacks epistemic evidence to sufficiently convey its worth to the non-designerly world.

Schön (1983) proposed “Reflective Practice” as “an epistemology of practice implicit in the artistic, intuitive processes which some practitioners... bring to situations of uncertainty, instability, uniqueness, and value conflict” (ivi: 48). His theory has been highly influential in education, healthcare and management professions and today knowing-in-action,
Despite decades of design cognition research, architecture still lacks epistemic evidence to sufficiently convey its worth to the non-designerly world.

2. Reflective practice constructs
Schön (1983) proposed Reflective Practice theory to lend credibility to experience as a form of intuitive knowing in-situ, distinct from (and superior to) the linear, rationalist approach advocated by others (ivi, pp. 21-69) – for example, Simon’s IDC model (Fig. 1).

2.1. Modes of design-thinking
Basing his argument on ethnographic data drawn from working practices of engineers, architects, town planners, psychotherapists, and business managers,
Schön found practitioners engaged in three cognitive processes while solving ill-defined, complex problems:

1. **Knowing-in-action**: intuitive performance developed through practice (p. 54).
2. **Reflection-in-action**: critical thinking occurring within the scope of a problem-solving activity (e.g., design project), often triggered by an unanticipated situation (p. 56).
3. **Reflection-on-action**: evaluation of a project or process after completion (p. 61).

### 2.1.1 Action present

Knowing-in-action and reflection-in-action are complementary processes, together forming an iterative approach toward managing complexity in ill-defined problems. Knowing-in-action is the physical expression of intuitive ‘knowing in practice’ (*knowing-how*). It reveals that “competent practitioners usually know more than they can say” (p. viii). Reflection-in-action is the explicit *thinking* complement (*knowing-that*) to knowing-in-action’s *doing*. It describes how people recognize what they know in the consequences of their moves – and that their knowledge may be deeper than what they could articulate ahead of time. “Doing extends thinking in the tests, moves and probes of experimental action and reflections feeds on doing and its results... each sets boundaries for the other” (p. 280). Through these two processes, the designer constructs the problem space by developing “an understanding of the situation” (p. 129). Schön used the term *action* to reference physically-situated ways people incorporate their bodies and environments (e.g., tools, materials, and other people) into their design-thinking systems. He also used *action* to define the scope of a design project; *action present* (p. 278) is the time-period when a designer’s action still affects the outcome of design project (p. 62). Knowing-in-action and reflection-in-action occur during action present, defining the conceptual problem space for a project or process (Fig. 2).

### 2.1.2. Learning from design cases

Reflection-on-action happens outside of a project scope. It is a process of rationalization postmortem involving critique of previous decisions and behaviors affecting solution outcomes. This is reflection for *future* action and Schön used the concept to explain...
Reflective practice emphasizes the uniqueness of design cases, however reflection-on-action is self-reflexive, metacognition by which a practitioner learns concepts, ideas, or skills that are transferable to other cases. Per Schön, ‘We reflect on action, thinking back on what we have done... to discover how our knowing-in-action may have contributed to an unexpected outcome’ (p. 26). Designers bring different perspectives to their work, including “values, goals, purposes, and interests” (p. 17) implicit in their knowing-in-action. Critical reflection-on-action identifies and resolves conflicts between implicit and explicit theories; it is common for actions (guided by theory-in-use) to be inconsistent with stated goals or intentions (espoused theory). Reflection-on-action surfaces similarities and differences between espoused theory and theory-in-use when practitioners compare what actually happened during a project with beliefs about the design. Tension arising from theory differences promotes new insights and learning, evolving design-rationale, expertise and professional growth.

2.2 Design-Thinking Expertise: Inquiry, Reflection, Reframing

2.2.1. Artistry through frame experimentation

Schön argued that design’s ‘crisis of confidence’ arises from inability practitioners have in explaining expertise (knowing-in-practice) – “making sense of uncertainty, performing artistically, setting prob-
Designers treat each design case uniquely, constructing knowledge through frame experimentation and developing expertise by reflecting on the case postmortem.

2.2.2. Specialization and intuitive knowledge
Designers treat each design case uniquely, constructing knowledge through frame experimentation and developing expertise by reflecting on the case postmortem. With practice, a designer “encounters certain types of situations again and again”, and becomes a specialist, developing “a repertoire of expectations, images, and techniques” (p. 60). A growing repertoire helps the designer better predict outcomes of actions. Less often surprised, her knowing-in-practice becomes increasingly intuitive and harder to explain. Specialization also brings fewer opportunities for reflection, increasing risk the designer develops “patterns of error” and “parochial narrowness of vision” (pp. 60-61).

3. Design thinking-in-action: embodied, embedded, enactive, predictive
Although published decades ago, Schön’s (1983) Reflective Practice theory describes the physically-situated2 nature of design-thinking. Today, scientists generally agree human cognition is both socially and physically situated (Anderson, 2003; Robbins, Aydede, 2009), meaning people’s knowledge cannot be separated from the socio-physical contexts where they develop and use it. Neuroscience research also suggests the mind is a sophisticated hypothesis-testing system. Supported by neurophysiological evidence, Predictive Mind theory describes brain function as a ‘prediction machine’ that continuously tries to match internally driven (top-down) expectations with externally driven (bottom-up) multi-sensory experiences in the environment (Clark, 2015). Schön’s concepts of knowing-in-action, reflection-in-action, and artistry suggest both physical grounding of cognition and predictive processing in design-thinking.
### 3.1. The Brain-Body-Environment Cognitive System

Situated cognition integrates theories from social psychology, ecological psychology, and biology to describe human cognition as dependent upon bodily characteristics, intellectual abilities, mood, activities, socio-cultural context, and physical environment (Gallagher, 2009). Three tenets (3E’s) take physical grounding as their focus: embodied, embedded, and enactive cognition. Embodied cognition explains how human perception is shaped by the characteristics and capabilities of the body (Gibson, 1977; Varela et al., 1991). Embedded cognition considers ways people exploit features of their physical (Clark, 2008) and social (Hutchins, 1995) environments to improve cognitive capabilities. Enactive cognition theorizes knowledge is constituted through a person’s actions in, and interactions with, their environment (Thompson, Varela, 2001). Central to each of these tenets is belief that action and perception are coupled, an idea supported by neurophysiology research on neural processing of vision and hearing and the brain’s mirror neuron system (Garbarini, Adenzato, 2004; Wilson, 2002).

#### 3.1.1. Ecological approach to perception

The 3E’s underscore the importance of action in perception (an idea central to Schön’s epistemology) and how people incorporate items from the physical environment into their cognitive systems. Form and capabilities of a person’s body along with its interactions with the external environment shape that person’s conception of the world (Wilson, 2002). This ecological view of cognition was popularized with psychologist J.J. Gibson’s (1977) Theory of Affordances. Gibson believed people understand the world in terms of functional relevance (affordances). Affordance is action opportunity constituted through the relationship between a person’s capabilities and features of the environment. The ecological view of perception suggests people are inherently goal-directed and wired for action; they perceive their environments in terms of the action opportunities (field of affordances) they present. Figure 3 illustrates how a person’s action in the world changes the field of affordances available to him and, in turn, his field of affordances affects his perception.

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3 - Two-stream hypothesis argues vision and hearing are each characterized by distinct systems: ventral stream (‘what pathway’) and dorsal stream (‘where/how pathway’). fMRI studies illustrate complementary responsiveness in the vision-for-perception and vision-for-action pathways.

4 - A mirror neuron fires when a person performs an action and when watching an action performed by another, suggesting object-action linkage in cognitive processing.
3.1.2. Embodied knowing-in-action
Knowing-in-action describes the embodied, practical knowledge people exhibit through doing. It has the following properties (p. 54):

1. Actions, recognitions, and judgments are carried out spontaneously, without prior thought.
2. People are often unaware of having learned them.
3. They are usually unable to describe the knowing revealed in their actions.

Schön’s story of Quist, an architect, and Petra, his student, illustrates how practitioners communicate embodied-knowing through drawing. Petra has problems with a complex slope in her design for a school. Quist places tracing paper over her drawing, demonstrating design expertise through knowing-in-action while drawing. His sketches reveal knowledge, with words mainly referencing what he is doing:

Quist’s lines are unclear in their reference except insofar as he says what they mean. His words are obscure except insofar as Petra can connect them with the lines of the drawing. His talk is full of dyctic utterances – ‘here,’ ‘this,’ ‘that,’ – which Petra can interpret only by his movements. (p. 81)

Quist is thinking by drawing. Drawing tools and paper are transparent equipment; he sees through them to externalize knowing-in-action (Clark, 2008). His body
helps constitute cognition through interactions with artifacts in the environment, in this case drawing instruments.

3.1.3. Embedded reflection-in-action

Reflection-in-action is an explicit process to remedy ‘bad fit’; it is triggered by a surprise when intuitive performance yields unexpected results (Schön 1983, p. 56). Feedback from “materials of a situation” (p. 78) prompt the designer to “surface and criticize the tacit understandings” of the problem (p. 61). Quist relies upon his repertoire of experience to select one problematic aspect of Petra’s design: the relationship between L-shaped classroom and site slope. He reframes the problem, suggesting geometry (“discipline”) be imposed upon the “screwy” site (p. 85). Then he conducts a frame experiment to test his idea by drawing plan and sections (pp. 86-87):

1. The L-shaped classrooms are carved into the slope as in sketch A [plan].
2. The ‘differentiation potential’ [of the site is 15’] shown in the sectional sketch B... The slope is now divided into three levels, one for each of the classrooms...
3. [Section] C shows the ‘interval’ from the ground on one level to the roof of the classroom... on the next lower level [5’].

Quist uses different drawings as things to think with while testing his frame experiment: imposing ‘discipline’ on the site. Each drawing reveals affordances explored in a subsequent drawing. In plan A, three L-shaped classroom buildings are arranged with respect to site topography. Affordances of this organization are investigated in section B, revealing a 15’ site drop (‘differentiation potential’) between classroom buildings at the top and bottom of the site. In section C, Quist examines affordances of stepping buildings in 5’ intervals. A new idea emerges: to provide ‘nooks’ for the children.

Reflection-in-action describes embedded cognition. Quist off–loaded cognitive work to his drawings to investigate tacit assumptions and reveal unanticipated affordances. Manipulation of features and qualities of the problem environment is critical even for experts like Quist to understand complex situations through “incremental cognitive self–stimulation” sustained by...
feedback from changing environmental conditions (Clark, 2008, p. 61).

3.1.4. Artistry enacted through conversation with materials

The enactive thesis describes how understanding is constituted through (enacted by) people's interactions with aspects of their environments. This concept aligns with embodied and embedded theories, because cognition that is embodied and embedded must also be enactive (Ward, Stapleton, 2012). Reflective practice describes a form of enactive cognition in that it focuses attention on the importance of action in ways practitioners intuitively manage complexity toward developing creative solutions to ill-defined problems (Malinin, 2016). Schön described this as artistry:

A designer makes things... Typically his making process is complex. There are more variables – kinds of possible moves, norms, and interrelationships of these – than can be represented in a finite model. Because of this complexity, the designer's moves tend, happily or unhappily, to produce consequences other than those intended... He shapes the situation, in accordance with his initial appreciation of it, the situation 'talks back,' and he responds... (p. 79).

Artistry is transactional and improvisational performance between designer and the product of his making, enacted by feedback from the materials of the design situation. He perceives-in-action as his idea takes form; shifting in stance he “must oscillate between involvement and detachment” (p. 102) in response to the conversation unfolding from the materials at his hand.

3.2. Mind: A prediction machine

Predictive Mind theory also emphasizes the importance of action in perception (Clark, 2015). The argument here is that our expectations shape how we experience the world, determining what we attend to with our sensory systems of sight, sound, smell, touch, and taste. The nervous system, it hypothesizes, is designed to adapt to uncertainty, providing real-time feedback from the environment to confirm or contradict expectations about it. The brain, wired to conserve resources, ‘surfaces uncertainty’ by comparing expectations to experiences, prioritizing attention where it is needed. Perceptions
of the environment that confirm expectations are not
given much importance. Instead, unexpected feedback
(Schön’s ‘bad fit’) is prioritized, and sensory inputs
improve accuracy of future predictions and behaviors.
Attention and action are bound together as an effortful
‘error detection’ system. Thus, sustained attention in
the absence of action becomes harder because the mind
craves new sensory information (Clark, 2015).

3.2.1. Knowing-in-practice: specialized prediction-sy-
stem
Knowing-in-practice is an intuitive, disciplinary-spe-
cific, ‘error detection’ process developed from pat-
terns of experiences in similar design cases.

As a practitioner experiences many variations of a small
number of types of cases... he learns what to look for and how
to respond to what he finds. As long as his practice is stable, in
the sense that it brings him the same types of cases, he becomes
less and less subject to surprise. His knowing-in-practice [be-
comes] increasingly tacit, spontaneous, and automatic... (p. 60)

Quist’s problem-solving repertoire includes “sites he
has seen, buildings he has known, design problems
he has encountered, and solutions he has devised for
them” (p. 138). He has acquired domain-specific tech-
nical expertise (for example, orthographic drawing)
and developed domain design-language (e.g., pro-
gram, site, elements, form, structure, scale, precedent,
representation, etc.) (p. 96). This repertoire structures
‘priorities for attending to features of a situation’
(p. 98) and shapes affordances he perceives.

3.2.2. Reflective practice is situated design-thinking
Schön’s concepts – knowing-in-action, reflection-in-ac-
tion, artistry, and knowing-in-practice – align with
cognitive theories of embodied, embedded, and en-
active perception and predictive mind. This analysis,
summarized in Table 1, suggests foundational princi-
plies underlying his constructs are valid and supported
by research from the mind and brain science. In the
next section, the analysis is used to evaluate criticisms
regarding conceptual clarity, implementation, and
socio-cultural context.

4. Limitations of Schön’s theory
Criticism of Schön’s reflective practice theory largely
come from problems associated with applying it to
instructional practices in teacher preparation, nursing programs (Boud, Walker, 2002; Ekebergh, 2007) and architectural education (Mewburn, 2012; Webster, 2008). These are reframed as three questions to consider:

- What distinguishes reflection-in-action from knowing-in-action and reflection-on-action?
- Is it possible to ‘reflect’ during intuitive activities?
- What role does socio-cultural context play in people’s abilities to critically reflect ‘in’ and ‘on’ their actions?

4.1. Reflection problems: Construct and implementation

What distinguishes reflection-in-action from reflection-on-action?

At the root of this question is that Schön used ‘reflection’ to describe different cognitive processes. The
In the context of architectural practice reflection-in-action would be fueled by feedback from abstracted representations of a design. However, the former he described as appreciative (p. 101), promoting “recognition of implications” in a situation (p. 103). It is directed toward the object of design. The latter, he explained, is a self-reflexive process whereby practitioners “can explore the [tacit] understandings they have brought to their handling of the case” (p. 61). Significantly, in the context of architectural practice reflection-in-action would be fueled by feedback from abstracted representations of a design (typically diagrams, drawings, and models) during the project phases of programming, schematic, development, and construction documents. Reflection-on-action, following action-present (e.g., the project scope), would thus be promoted by unexpected outcomes of building use (e.g., from post-occupancy evaluation). This distinction between reflection-in-action and reflection-on is unclear, in part, because Schön used an educational setting to explain his concepts.

What distinguishes reflection-in-action from knowing-in-action?

Schön also muddies the distinction between knowing-in-action and reflection in action. He describes different reflective processes during reflection-in-action, calling them different stances: “involvement” and “detachment” (p. 102). Involvement refers to an intuitive process of “thinking on your feet” (p. 54), when people “find the groove” and have a “feel for” a situation, making “on-the-spot adjustments” to their performance (p. 55). Detachment is an explicit assessment of a situation that “hinges on the experience of surprise” (p. 56). It is a way to rectify ‘bad fit’ by surfacing tacit understandings that may have led to the situation, and then developing new intentions (‘appreciations’) toward it – often by reframing the problem. He fails to explain differences (if any) between the involvement stance of reflection-in-action and knowing-in-action – which he describes as intuitive knowing “implicit in our patterns of action and in our feel for the stuff with which we are dealing... (p. 49).

Is it possible to ‘reflect’ during intuitive activities?

Although he described both intuitive and explicit processes of reflection-in-action, Schön acknowledged reflection will interfere with action (pp. 277-279). He
asserted, however, that this apparent contradiction is due to misunderstanding that thinking must be separate from doing—and because there are different types of reflection (involvement versus detachment). He failed to resolve this apparent conflict between intuitive doing and reflecting, stating that even if reflecting-while-doing is feasible, it could be dangerous (p. 277). He suggested instead that thinking and doing are complementary processes that build off of each other; “doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results” (p. 280). This explanation seems to contradict his examples of (involvement-stance) reflection during improvisational performances, such as while pitching a baseball or playing jazz (p. 55).

4.2. Evolving design-rationale problem: Socio-cultural context

What role does socio-cultural context play in abilities to critically reflect ‘in’ and ‘on’ actions? Schön acknowledged designers bring different perspectives to their designs through implicit “values, goals, purposes, and interests” (p. 17). He suggested feedback from actions promotes opportunities to surface and challenge tacit assumptions by reflecting ‘in’ and ‘on’ action. Designers’ abilities to perceive affordances for reflection, however, are limited by their learned bodily behaviors (e.g., skills/training), domain knowledge, norms of practice, and shared organizational expectations. Schön considered the role of organizational structures in promoting or inhibiting reflection (p. 242), but neglected to consider how organizational culture shapes perception and ways people resist, violate, or transform shared expectations of their design firm or general field of practice (Webster, 2008).

5. Extending Schön’s epistemology

Although Schön captured the physically-situated nature of design-thinking, he left the concept of reflection vague—perhaps intentionally so, since his purpose was to free design from the limits of technical rationality. For a more complete epistemology of architectural practice, the limitations discussed in the prior section must be addressed. To that end, a conceptual framework is proposed here that extends Schön’s theory in two ways:
1. It proposes clearer definitions for different forms of reflection, by illustrating cognitive processes involved.

2. It suggests how to incorporate socio-cultural contexts of reflection within its purpose for evolving design-rationale and organizational transformation.

5.1. Reflection to evolve creativity

You stop thinking,
you just look at the piece of foam and you try to make it beautiful,
you cut.
Sometimes you slice something,
and then another thing,

and ou-u-u-p-p-p something is there.
And you think:
“Oh, that's interesting;” it’s there. (Yaneva, 2009, p. 57)

This quote from Yaneva's (2009) study of the Office for Metropolitan Architecture (OMA) serves to illustrate how Schön’s concepts of knowing-in-action and reflection-in-action might be clarified to more accurately represent design cognition during action-present., In it Olga, an architect, explains how she comes up with ‘a smart idea.’ She describes involvement (first part) and detachment (second part) stances similar to Schön’s reflection-in-action. However, Olga does not stop-and-think when cutting the foam to reflect on each outcome of an action; instead she ‘stop(s) thinking.’ Each cut is intuitively confirmed to align with her intentions until she realizes ‘a bad fit’ and is happily surprised by the outcome. Surprise gives her pause to assess (think about) the opportunities in this unexpected outcome. Before her moment of surprise, Olga is perceiving-in-action, a process of tacit error-detection. Her knowing is in her actions and she perceives by doing. The ‘involvement’ Olga describes sounds like Schön’s knowing-in-action; she intuitively knows what is good (predicted) and what is ‘bad fit’ (unpredicted). Each action is guided by prior embodied, foam-cutting experiences and perceived affordances shaped by prior practice, personal values, and the workplace socio-cultural environment (Fig. 4).

Olga’s creativity evolves through action, intuitively “recogniz[ing] bad fit within a familiar pattern”
(Schön 1983, pp. 52-53). She describes this feeling (ou-u-u-p-p something is there), which triggers a semi-detached stance (And you think) for reflecting-in-action (“Oh, that’s interesting;” it’s there). Olga’s reflection is valuative and situated in action; she might rotate the foam to help perceive opportunities in the model. She becomes aware of her thinking (it is explicit). Yet valuation remains guided by intuitive knowledge embedded in the foam (it’s there). This is not critical reflection; Olga may ignore some problematic features or personal assumptions in order to help identify unforeseen affordances in the design.

When analyzed with respect to knowledge from cognitive science, examples of architectural practice like Olga’s and Quist’s help clarify Schön’s knowing-in-action and reflection-in-action constructs. Theoretical perspectives of enactive cognition and predictive mind suggest Olga is predictively-perceiving-in-action when involved in foam-cutting; she anticipates the outcomes of each action during her performance. Schön’s ‘involvement’ stance, therefore, may more accurately describe knowing-in-action than reflection-in-action, because it appears guided by intuitive prediction/error-detection processes as opposed to reflection. Reflection-in-action is conceptually clearer when limited to the (semi) ‘detached’ stance and explicit process of valuative reflection. In practice.
these two complementary processes often appear intertwined (e.g., Quist’s artistry example in Table 1), particularly as professionals develop artistry, expertise in evolving creative exploration by moving fluidly between involvement and detachment (Fig. 5).

5.2. Reflection to evolve design-rationale and practice
Schön claimed practitioners acquire expertise by evolving design-rationale through reflection on-action and on-practice. Reflection-on-action helps a practitioner develop specialization—the ability to more accurately predict outcomes of intuitive actions. Reflection-on-practice, however, is crucial for avoiding the pitfalls of specialization: narrow vision and replicating patterns of error (ivi, pp. 60-61). Despite arguing their importance, Schön gave little attention to how these processes are promoted in professional practice or what factors they involve. Given what we know about how learning is socially (as well as physically) situated, the importance of organizational and disciplinary culture should be accounted for in epistemology of architectural practice.

First, the role of critique must be considered with respect to project team and firm (design business). Critique is central to evolving design-rationale because reasoned opinions of other people about design products or actions can trigger reflection-in-action or reflection-on-action (Fischer et al., 1993). Schön simplified the critique interactions between Quist and Petra, focusing on Quist’s role as expert in modeling reflective practice. Schön’s critics argue he ignored power dynamics, warning that Quist imposes his values and

Fig. 5 - Artistry.
Design professionals fluidly move between the complementary processes of knowing-in-action and reflection-in-action to evolve creativity through intuitive experimentation, error detection, valuative reflection, and problem reframing.

Critique is central to evolving design-rationale because reasoned opinions of other people about design products or actions can trigger reflection-in-action or reflection-on-action.
Professional design practice is situated in the socio-physical context of a firm, which affects employee’s values and philosophies along with available tools, materials, and methodologies they use to think-in-action.

design philosophy when mentoring Petra (Mewburn, 2012; Webster, 2008). Similar power dynamics occur in professional teams, where interns might work in collaboration with licensed project architects or firm partners. Further, Mewburn (2012) points out Schön ignored instances when Petra questioned Quist’s methodologies. In so doing, Schön missed an opportunity to explore how feedback from others (including novices) can help experts overcome pitfalls of specialization by engendering reflection. Professional design practice is situated in the socio-physical context of a firm, which affects employee’s values and philosophies along with available tools, materials, and methodologies they use to think-in-action. The design team typically includes members from inside and outside the firm, including allied professionals (engineers and contractors) and building stakeholders holding different values, philosophies, skills, and methodologies. Feedback from various forms of critique (e.g., novice, expert, cross-disciplinary) and methods of ideation/visualization (e.g., diagrams, drawings, models, etc.) help professionals evolve design-rationale, such as by recognizing tacit repetition of ineffective or problematic design patterns.

Second, the role of feedback from implementation and use is essential for a more complete epistemology of architectural practice. Schön’s example of reflective practice involved the architectural studio where students worked on simulated projects that were never built or used by occupants. Direct feedback from design use is necessary for making salient to the designer unexpected outcomes of the postmortem design project, triggering reflection-on-action (McCall, 2013). Critical reflexivity helps the designer evolve design-rationale by surfacing underlying assumptions, reframing problems, and developing new theories of action that may be applied to future design situations. Without feedback from building use there is often insufficient stimulus to effectively promote critical reflexivity (Malinin, Cunningham, 2014). This suggests the ability to evolve design-rationale rests heavily on effectiveness of post-occupancy evaluation (POE) processes to elucidate expected and unexpected outcomes of a building design. Firm organizational culture, however, determines if and how POE’s are conducted, including what information might be considered valuable and whether affordances revealed by POE’s are perceived or actualized to evolve design-rationale.
Finally, a more complete epistemology must consider how architectural practice evolves within the firm and discipline as a whole. Certainly critique and POE processes play a role, however these typically evoke incremental changes. If we consider ‘cultures of practice’ are shaped by domain knowledge/skills and organizational norms, methods, and procedures, then reflection-on-practice might best be promoted through feedback from outside that culture. For example, transformational practices like Universal Design or Biomimicry are responses to disruptive pressures from outside the field to prioritize accessibility and sustainability in architectural solutions. Disruptive technologies are also common triggers for reflection-on-practice; they may help curtail unproductive group-think arising through shared knowing-in-practice, inviting organizational transformation (Malinin et al., 2016). For example, building information model (BIM), 3d printing, virtual and augmented reality (VR/AR) are a few technologies impacting design practices today. Paradigm shifts are often caused by external disruptions that challenge assumptions, methodologies, or philosophies within a community of practice (Crilly, 2010; Kuhn, 1996). Disruptions trigger reflection-on-practice by inciting practitioners to re-examine previously established disciplinary knowledge. After a period of resistance (or critique), disruptive pressures may ultimately yield transformation of disciplinary values, philosophies and methodologies.

The central theme underlying reflective practice constructs is the importance of feedback – from materials (e.g., products, tools, and technologies) and critique – in promoting reflection, helping the designer ‘surface uncertainty’ to evolve thinking about complex problems.

- For knowing-in-action, feedback confirms intentions (predictions), helping the practitioner maintain attention by responding to new sensory information in the situation.
- Reflection-in-action relies on the designers’ perception of unexpected feedback from actions to detect and remedy ‘bad fit’
- Reflection-on-action hinges on feedback from implementation and use (i.e., critique external to the
firm) to stimulate critical reflexivity and evolve design-rationale.
• Reflection-on-practice is triggered by external disruptions to established assumptions, methodologies, values or philosophies within a practice community and promotes new paradigms.

Figure 6 provides a conceptual sketch, extending Schön’s epistemology of practice with the ideas proposed in this section, as a step toward defining a more complete picture of how design-thinking knowledge is constructed and evolved through architectural practice.

6. Conclusion
In the 1980’s Schön examined designers’ lived experiences, describing how they exploit affordances in their environments when thinking-in-action to extend cognitive abilities. His epistemology of practice granted credibility to experience and intuitive know-how (artistry) – and introduced concepts foundational to modern theories of embodied, embedded, and enactive cognition. He explained how designers overcome their natural tendency to fall into patterns of prediction, employing design-thinking to ‘surface uncertainty’ and perceive unforeseen affordances in problematic situations. Although incomplete, reflective practice theory provides a solid foundation upon which to build a more complete epistemology of architectural
practice. It underscores how architects rely on technologies (non-humans), to promote reflection, thereby improving capabilities for managing complexities of design practice and challenging tacit understandings in ill-defined situations. By extending Schön’s theory we may compose a more complete picture of architectural practice, lending legitimacy to it methodologies and the creative value it brings toward solving complex societal problems.

References


