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Toward an Architectural Theory of Innovation: Explicating Design, Networks, and Microprocesses

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Abstract

A growing body of literature confirms the need to better understand the processes and institutional underpinnings of organizational change, especially for those transformational efforts aimed at improving innovation, sustainability, and ethical governance. Although critics have called for more scholarship on design culture as a potential source of insight, the question of how others outside of management disciplines might approach sustainable organizational and institutional change and innovation has been principally underexplored. For this qualitative ethnographic study, we collected and analyzed design practice artifacts produced by Architects in order to gain empirical insight into the systemic process antecedents of change, innovation, and sustainability. The paper contributes explanations of design culture, the deployment of abductive reasoning and figure-ground assignment. In addition, it identifies and sheds theoretical light on three (3) emergent change process constructs: paradoxical cognition, network ensembles, and interpretive microprocesses. The paper concludes with an integrative discussion, critical comments, and additional areas for future research.

Keywords: abductive reasoning; architects; boundary devices; change; creativity; design culture; divergent thinking; figure-ground; governance; innovation; institutional theory; interpretive microprocesses; network ensembles; paradox.

Introduction

> Recent arguments by institutional theorists suggest that one of the most promising planks for the development of institutional theory is combining an analysis of the structural and practical aspects of organizations and institutions with a theorization of the microprocesses of cognition (e.g., framing, categorization, or sensemaking) and communication (e.g., interaction or rhetoric) through which those structural and practical aspects are maintained, challenged, or changed. (J. Lammers, Cornelissen, Vaara, Durand, & Fiss, 2013: para. 1)

Understanding the complex correspondences and paradoxes emerging from the interplay of institutional and organizational change is a burgeoning area of interest to scholars, policy makers, and practitioners. While scholars have made much progress toward understanding the discrete domains of institutional change and organizational change, as the quote above infers a growing number

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of voices are calling for more research. Of concern, is the dearth of insight about the systemic interactions among institutions and organizations undergoing transformation, generally with the aim of enhanced innovation (Hutter, Kuhlicke, Glade, & Felgentreff, 2013; C. J. Lammers & Hickson, 2013; Muzio, Brock, & Suddaby, 2013). Few scholars have holistically examined institutional fields and organizations together as systems. In this paper, we examine the processes of governance and change across organizations and institutions as a system. Accordingly, we metaphorically conceptualize them as "universes".

These universes consist of embedded temporal constellations of networked organizations, bounded groups of humans and technologies, held together by legitimized constraints or normative logics of appropriateness (March & Olsen, 2006), emanating and morphing from discursive practices (Gofas & Hay, 2010; Peters, 2012; Schmidt, 2010). These universes are robust and dynamic systems rich with the constant ebbing and tiding of pressures, shifting arrangements, complex interactions, ordered action, randomness, feedback, and transformations. Furthermore, few have deeply studied the particular design processes (e.g., framing, categorization, or figure-ground perception) and communication (e.g., interaction or discursive practices) at work in these universes, especially those microprocesses involved with enabling change and innovation.

Concurrently, other scholars have called attention to the inadequacies found in our extant and legitimized theories of change. C. J. Lammers and Hickson (2013) note that institutional change and innovation are not well understood, especially microprocesses. Change scholars have criticized current approaches as vague and lacking necessary specificity (Lüscher & Lewis, 2008). Still other scholars have characterized the change and innovation literature as fragmented, incomplete, and argue that a unifying theory, one that overcomes internal inconsistencies evident in current approaches, might be useful (Packard, 2013). Although sustainability as a theme of change may be assumed, it is often not explicitly addressed (Salzmann, Ionescu-Somers, & Steger, 2005). Innovation harm and ethics are not adequately addressed (Ashforth, Gioia, Robinson, & Trevino, 2008; Campbell, 2007; Edgell & Vogl, 2013). In addition, many scholars suggest that history and context are important, but few have posited the particular ways in which these might be antecedents of change (Reed, Miller, & Francisco, 2014). The literature often assumes that organizations are either mechanisms or organisms (Anderson, 2012), but has rarely adopted an integrated sociotechnological perspective (S. Cooper, 2002; Latour, 2005; White, 1995). Lastly, both scholars and practitioners offer evidence which suggests that widely accepted and legitimized change approaches are not satisfactory (Taylor-Bianco & Schermerhorn Jr, 2006). Research indicates that change projects, as judged by participants, often fail to meet expectations (Oakland & Tanner, 2007).

To help us gain insight into the research gap delineated above, we concentrate on design culture given the growing body of practice-based

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literature (see Erden, Schneider, & von Krogh, 2014) which indicates that aspects of design practices may offer insights and antecedents to successful change and innovation (Beckman & Barry, 2007; Boland & Collopy, 2004; Brown, 2009; Dunne & Martin, 2006; Gharajedaghi, 2011; Hassi & Laakso, 2011; Lucy Kimbell, 2011; L. Kimbell, 2012; R. L. Martin, 2009; Mootee, 2013; Seidel & Fixson, 2013). In particular, we seek insight from studying a type of designer, Architects, and the ensuing practice of architecture. The State of New York defines architecture as " … to render services which require the application of the art, science, and aesthetics of design and construction of buildings … " (AIA, 2012, p. 11)

The designing or redesigning of organizations embedded in dynamic institutions is conceptually similar to the work of Architects who rigorously design new or rehabilitate old buildings, often for use by organizations. These structures exist as entities or components of larger multi-constituent and dynamic institutional landscapes. Many scholars have documented the creativity and innovativeness of Architects and the various related institutional shifts such as the introduction of LEED certification incentives and the emergence of "green" building code regimes (Circo, 2008; De Lapaz, 2013; Diamond, Opitz, Hicks, Von Neida, & Herrera, 2006).

Architects through the use of dynamic design processes alter institutional fields--new buildings or renovations introduce macro and micro shifts in localized environments (Vallero & Brasier, 2008). For example, a new building might impact site usage patterns or require a zoning variance that would encourage others to follow suit. Furthermore, it might introduce innovative features that eventually become performance standards incentivized by legitimizing agencies or demanded by regulatory regimes (see Lipman's (1986) explanation of Frank Lloyd Wright's "lily pad" column code variance).

Over several centuries, Architects have evolved a robust codified standard model for change and innovation that enables a productive duality of creative "messiness" and institutional restraint or "order" (AIA, 2013; Vallero & Brasier, 2008). The official codified standard model typically includes the following core phases (in temporal order): Programming, schematic design, design development, construction documents preparation, and construction administration. In recent years post occupancy evaluation has become a legitimized final phase. This overarching phased process is rigorous, iterative, and generally flows from concepts to particulars. It consists of several linked cognitive processes, such as abductive reasoning, and other microprocesses and discursive practices that enable variation and evolution throughout while delivering ordered, sustainable, and ethical (e.g., safeguarding human health, safety, and welfare) structures that address complex human and technological problems. However, we seek to understand not only the obvious arranged aspects of this broad process, but also the less-obvious or hidden dimensions that also are present when applying the codified standard model to actual projects.

Although there is a growing body of innovation literature that highlights the

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possible prescriptive benefits of “design thinking”, often focused on practitioners (Boland & Collopy, 2004; Brown, 2009; Dunne & Martin, 2006; Jelinek, Romme, & Boland, 2008; R. L. Martin, 2009; Romme, 2003), none have scientifically explored the particular constructs and microprocesses involved. Furthermore, other scholars, while providing useful insight, have narrowly focused on particular aspects of design such as the studio process (R. Cooper, Junginger, & Lockwood, 2009; Raghu Garud, Jain, & Tuertscher, 2008; Junginger, 2007).

Our research is guided by the questions, What are the emergent practices, devices, and process constructs of sustainable innovation that may be transferred from the work of Architects to the domain of institutional and organizational change? and How do Architects navigate the correspondences and paradoxes inherent in creating complex and institutionally constrained systems comprised of diverse actors and evolving technologies? To answer these questions, we begin this exploration by first reviewing the literature and defining change, innovation, design culture, abductive reasoning, sustainability, and other relevant terms. Next, we describe our site and delineate our qualitative method. For this ethnographic study, we collected and analyzed data from innovation and sustainability artifacts produced by Architects. As the primary feature of this paper, we contribute rich descriptions of three (3) emergent change constructs: paradoxical cognition, network ensembles, and interpretive microprocesses. Although beyond the scope of this paper, we foresee these constructs becoming potential antecedents, with additional causal research, for a more complete and robust theory of change. We then conclude with critical comments and additional areas for future research.

Change, innovation, design culture, and abductive reasoning

Conceptually, change is rather simple to understand; it is deliberate or random acts of transitioning from one state of existence to another different state of existence. In contrast, change and transformation, in our universes rich with networked organizations and normative logics, are difficult. Institutions often arise to counter excessive social disruptions and pernicious organizational actions by providing harmonization, integration, and transmission. However, there is growing consensus among scholars that institutional change is possible and predicted through gradual processes (Battilana, Leca, & Boxenbaum, 2009; Boxenbaum & Rouleau, 2011; Duymedjian & Rüling, 2010; Mahoney & Thelen, 2010; Pettigrew, Woodman, & Cameron, 2001). The discursive and, to some degree, the sociological views of institutionalism provide gradual institutional change approaches. Discursive theory suggests that institutions incrementally change in response to slowly emerging and shifting social ideas and values that are broadly discussed (Peters, 2012). Communication and narrative practices have been, throughout human history, antecedents to technological innovation (Bartel & Garud, 2009; Sahle et al., 2013). Despite the persistence of discursive practices and agreement about the efficacy of such approaches, there is

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mounting scholarly concern that particular microprocesses are not well understood (Fligstein & McAdam, 2012; Lok & Rond, 2013; McPherson & Sauder, 2013; Stephansen & Couldry, 2014).

In our networked organizations, we are most concerned about change related to innovation and discursive practices (Bartel & Garud, 2009). Innovation is an information-driven distributed agency process of changing social institutions and markets so as to permit the acceptance of novel and tradable value or utility often emanating from a focal organization (Edgell, 2013; Edgell & Vogl, 2013; Fischer, 2000; R. Garud & Karnøe, 2003; Hargadon & Douglas, 2001). In this view, power or utility is derived from networks of humans and technology which, in a Latourian sense, takes various beneficial forms including products or services, production processes, organizational arrangements, and even institutional fields (Latour, 2005). Technology, in contrast to nature, is any construction by humans and other technology. It is this emergent view that offers the possibility for understanding the correspondences and paradoxes emerging from the space between institutional and organizational innovation. Furthermore, we agree with the United Nation's widely-accepted definition of sustainability: sustainable innovation activity meets the evolving needs of present humans without diminishing the ability of future humans to fulfill their needs (Brundtland, 1987). This implies that organizations should be ethical and, therefore, purposefully minimize any harm resulting from their evolving innovation processes while creating benefits for current and future citizens (Campbell, 2007; Edgell & Vogl, 2013).

As discussed above, a growing body of literature posits that systemic design thinking may prove useful insight for guiding organizations so they are more ethically stakeholder focused and inventive (Beckman & Barry, 2007; Boland & Collopy, 2004; Brown, 2009; Dunne & Martin, 2006; Gharajedaghi, 2011; Hassi & Laakso, 2011; Lucy Kimbell, 2011; L. Kimbell, 2012; R. L. Martin, 2009; Mootee, 2013; Seidel & Fixson, 2013). However, scholars are only beginning to develop a scientific understanding of design thinking (Hassi & Laakso, 2011; Hobday, Boddington, & Grantham, 2011, 2012; Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013). Certain scholars have proposed that "design thinking" be more scientifically re-conceptualized as "design culture" since many of the attributes commonly associated with this literature may more accurately represent accepted definitions of "culture" rather than "thinking" (cognition) as defined in the social sciences (Edgell, 2014). There is longstanding agreement that culture is the collective schemas and scripts or consciousness associated with a social group (Goldmann, Mayrl, Rodríguez, & Zimmerman, 1976, p. 31). Consciousness is a group's attitudes and actions that reflect deeply held values encompassing notions of "… space, time, good, evil, history, causality …" (Goldmann et al., 1976, p. 34). By arguing for the conceptualization of design intentions and activities as culture, it follows that the ethnographic study of designers might yield insights about both the microprocesses and the outcomes associated with systematic design approaches. We posit that this may provide insight about

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successful change and innovation given the conceptual similarities between the work of Architects who rigorously design structures enmeshed in localized community fabrics and the work of those who pursue change and innovation activities for organizations entangled in networks and institutional universes.

Accordingly, we use the term “design culture” and postulate that it may provide a framework for evolving purpose, identity, self-efficacy, creative action, and sensitivity to the needs of others (Brown & Wyatt, 2010; Bruce, 2009), especially for those involved with change and innovation. Boland and Collopy (2004) describe design thinking or culture as an attitude that is concerned with problem framing and solving with the underlying intent to improve benefits for the greatest number of stakeholders possible. Glück, Ernst, and Unger (2002) and Edgell (2014) define Architects as "constrained artists"—those who embrace limitations imposed from a variety of sources such as the physiological and psychological needs of others, science and the physical limitations of materials, regulatory environments, cultural values, etc. In systems theory, constraints place limits on novelty and, as such, act as feedback that balances systems so they function effectively.

First among the normative attitudes of designers is a belief that the built environment, conceived by the melding of scientific and engineering rigor with aesthetic sensibilities, should be highly instrumental for humans (Tung, 2006). This value manifests through the three longstanding historical and persistent normative principles of venustas, firmitas, and utilitas (Gharibpour, 2012). Venustas refers to the desire for aesthetics or human pleasure derived from interacting with the system. Firmitas speaks to the need for durability or systemic integrity that is maintained over life cycles or extended time periods. Lastly, utilitas reminds designers to make buildings that are highly functional for humans. In practice, Architects use these three principles among others, as overarching path creation constraints, when envisioning constructed environments. Architects conceptualize built environments as networked systems rich with varied inter-dependent technological and human components, balancing and reinforcing feedback loops, constraints and affordances, tensions and paradoxes, and inputs and outputs (Lüscher & Lewis, 2008; Marshall & Brown, 2003). Consequently, designers tend to favor large, complex, and participatory multi-constituent projects (Kolko, 2010). Furthermore, they engage in framing and deep immersion into problems, searching for meanings and assumptions, as antecedents to solving (Kolko, 2010). A growing body of literature indicates that they rely heavily upon visuo-spatial intelligence—the visualization of three dimensional space and objects also known as mental rotation (Goeke, König, & Gramann, 2013; Moustafellos, 2014; Prokýsek, Rambousek, & Wildová, 2013; Schnabel & Kvan, 2003; Sorby, 2009; Uttal et al., 2013). By deploying visualization techniques for abduction, designers may gain cognitive benefits in the form of greatly reduced inference sorting and determination associated with written or spoken language (Thagard & Shelley, 1997). Architects and designers use common visualization techniques including

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concept mapping, sketching, and prototyping (e.g., building physical scale models) that embody or explain ideas. These techniques allow for iterative and abductive modeling of various novel scenarios for systemic arrangements. Designers usually generate diverse scenarios so that they may explore tradeoffs stemming from perceived and physical paradoxical tensions (e.g., conflicts and contradictions) among the system components and constraints (Venturi, 1966). The codified standard model, discussed above, usually follows a temporal progression flowing from problem immersion and abstraction to conceptual solutions and concrete particulars. The process continues until tradeoffs are optimized by yielding a scenario or option which, relative to other options, satisfies the greatest number of constituents' needs and task constraints. Research reveals that from an affect perspective, constrained designers feel that creativity is indeed a difficult and painful process, often fraught with tension (Glück et al., 2002). Although designers primarily use inductive and deductive modes of reasoning during the problem immersion phase to determine constraints, they switch cognitive mode to abductive reasoning during the generative conceptualization of solution options.

As a means for deeply understanding constituents' material and psychological needs, designers often embrace discursive, participatory power sharing practices with a variety of stakeholders. During problem immersion, designers not only delineate actual constituents' objectives and potential obstacles vis-à-vis the project, but also embrace human health, safety, and welfare constraints, usually in the form of regulatory regimes. After comprehensively gaining insight about task constraints, designers typically engage in collaborative ideation sessions, often referred to traditionally as charrettes or more contemporarily as hackathons (Cardona & Tomancak, 2012). These ideation sessions are intensive, iterative, and generative with sketching and prototyping (as described above) under tight time constraints and often with collective participation by diverse constituents. Scholars have used the terms "co-creation", "meta-design", "social creativity", and "distributed innovation agency" to describe these participatory and discursive practices among designers and varied constituents (Fischer, 2000; R. Garud & Karnøe, 2003; Noweski et al., 2012). There is strong agreement among scholars that designers value pluralism with high and persistent stakeholder involvement (Dunne & Martin, 2006; Kolko, 2010; Noweski et al., 2012).

Central to the design processes described above are the use of diverse cognitive reasoning modes. Reasoning is the cognitive use of logic, in various forms, to make sense of phenomena and situations by constructing explanatory rationales. Abductive reasoning is often conceived as the rationale for the seemingly most plausible explanation based on current observations and reflections stemming from prior understandings of a phenomenon (Kolko, 2010). More specifically, abduction is logical inference in the form of a trial-and-error iterative process that generates hypotheses as best guesses to arrive at potential, yet uncertain, explanations that may or may not be true (Kolko, 2010;

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Mantere & Ketokivi, 2013; Peirce, Cohen, & Dewey, 1923, 2010; Schvaneveldt & Cohen, 2010). In contrast, deductive reasoning logically presents absolute or nearly certain and universal truths, derived from true premises. Inductive reasoning differs from abductive and deductive in that hypotheses are generalized or induced from specific and limited (bounded) observations. In a sense, inductive reasoning aims for, but does not guarantee universal truth and is restricted by the boundaries of specific observations (Arthur, 1994; Kolko, 2010). For ideational purposes, both deductive and inductive forms of reasoning are of limited usefulness since they can only offer existing information that was embodied in the known premises (Kolko, 2010). While deductive and inductive are most useful for aspects of problem immersion and analysis (Beckman & Barry, 2007), only abductive reasoning offers the potential for generating new findings and is sometimes referred to as "generative abduction". Abductive reasoning has a long tradition of usefulness in the physical sciences as well. Einstein's theory of general relativity is an example of significant scientific revelations that emerged from the use of abductive reasoning (Schvaneveldt & Cohen, 2010, p. 11). Accordingly, the cognitive use of abductive reasoning may be a necessary antecedent for novelty generation. Abduction allows for the generation of possible explanations when empirical information is either relatively limited or not feasible to collect. Lastly, abductive reasoning may work best for relativistic phenomenon that materialize from socially constructed situations in which there are constraints, but fewer positivistic absolutes.

Furthermore, emerging research explores "figure-ground assignment" (FGA), the ability of individuals to sort various components of images into close (figural) and distant (ground) planes, thus providing a sense of depth or dimension to a visually observed situation (Froyen, Feldman, & Singh, 2010). Present research suggests that FGA is important for mental rotations ability (visualization) (Froyen et al., 2010; Goeke et al., 2013) and, thus, positively influences novelty generation.

Despite what we know about design culture, abductive reasoning, and figure-ground assignment, the current literature offers little evidence or understanding of the systemic interactions among these variables. Also, there has been little research on FGA as well as the possible existence of other less-obvious or hidden dimensions that may contribute to design efficacy. Through this paper, we provide an initial glimpse into these interactions by studying textual artifacts produced by Architects. We focus on exploring the nuanced antecedents, especially abductive reasoning and FGA, embedded in the larger standard model design process. Our ultimate aim, with additional research beyond the scope of this paper, is to construct a more complete and predictive theory of concurrent change in institutions and organizations.

Site and method

For our exploratory ethnographic research, we examined textual artifacts, case studies, produced by Architects. Members of the American Institute of

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Architects (AIA), with the assistance of students enrolled in architectural programs at various universities, authored the cases. The AIA defines its mission as the "… the voice of the architectural profession … " (AIA, 2014a, p. 1).

Overall, the cases are discursive acts that aim to not only sustain the institution of architecture, but also further legitimize Architects' roles as master designers. Architects are an ideal group to study since, as many scholars have documented, they are recognized as being highly innovative and have been at the forefront of the sustainability movement which has resulted in institutional changes such as LEED certification incentives and "green" building code regimes, among others (Circo, 2008; De Lapaz, 2013; Diamond et al., 2006). Architects tend to be deeply concerned about sustainability since buildings are typically expected to last for 50 to 100 years (AIA, 2013), withstand various environmental challenges, and be adaptive (due to long life horizon) to emerging or unforeseen needs (Raghu Garud et al., 2008; Gharibpour, 2012; Vallero & Brasier, 2008). Although referred to as a discipline, the study of architecture is, by definition, actually interdisciplinary since it encompasses physical sciences, technological sciences and engineering, behavioral sciences, visual arts, humanities, the law and regulatory regimes, and health sciences (AIA, 2013; Gharibpour, 2012; Vallero & Brasier, 2008). Moreover, architecture is an ancient profession that dates back to at least Imhotep in Egypt around 2600 BC (Kemp, 2005, p. 159). Architects have refined, through the institutionalized transfer of knowledge over several centuries, a robust design model, infused with Vitruvian ideals, for designing buildings that are aesthetically pleasing, durable, and functional (Gharibpour, 2012). During the past century, Architects have been at the forefront of the interplay of institutional change and aspects of technological innovation such as the Bauhaus's attention to technological adaptation (Droste, 2006), green building's focus on sustainability (Banham, 1969; Hawkes, 1996), and smart building's application of artificial intelligence (Irani & Kamal, 2014).

The AIA Case Study Initiative called for the rigorous preparation of case studies or discursive artifacts to further develop the discipline of architecture and to diffuse information about the contemporary practice of architecture to the general public (AIA, 2014c). Furthermore, the AIA provided preparation guidelines that instruct authors to include an abstract, lessons learned, perspectives and stories of various constituents, and analysis of particulars relevant to the case (AIA, 2014b). Our research encompassed the total number of cases publicly available at the commencement of our data collection and analysis phase. These fourteen (14) cases totaling 577 pages of content, each providing a rich account of a particular architectural project, as described in Table 1. These cases are heterogeneous by building type, size, treatment type, context type, and sustainability efforts. Beyond these cases, the AIA offers other genres of artifacts including contract documents, a website with the AIA KnowledgeNet, advocacy guides, awards, documentation of best practices, continuing education content, incentive mandates, and conference and events (AIA, 2014d). Although we limited our initial research to these case studies, we

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also pull from other genres in our findings and discussion sections below.

Table 1. Summary of artifacts (case studies)

Case Study and Project Specifications **(building type, square footage, treatment, context, and sustainability)** **Note:** For industry standard building type taxonomy see Architectural Record (2014).
Asbury Villas (Schlossberg et al., 2000). Multifamily Residential; 71,000 SF; New; Suburban: Mt. Lebanon PA. No explicit mention of sustainability or energy reduction measures.
Baker Hall at Carnegie Mellon University (Hunter et al., 2001). Colleges & Universities; 29,254 SF; Rehab; Urban: Pittsburgh PA. No explicit mention of sustainability or energy reduction measures.
Big-D Construction Corporate Office Building (Argyle, Day, Messenger, & Tuft, 2006). Office Buildings (Adaptive Reuse); 67,900 SF; Rehab; Urban: Salt Lake City UT. LEED Gold.
Durham Research Center (Hedges & Elijah-Barnwell, 2005). Laboratories; 286,506 SF; New; Urban: Omaha NE. Meets some LEED standards (conflicts with institutional requirements for hospitals and labs).
Exploris: The Children's Museum About the World (Anonymous, 2000). Museums; 84,000 SF; Rehab; Urban: Raleigh NC. No explicit mention of sustainability or energy reduction measures.
Fire Ridge Elementary School (Diercks et al., 2006). Schools K-12; 58,000 SF; New; Suburban: Elkhorn NE. Limited sustainability measures deployed.
First National Tower (Vidlak et al., 2004). Tall Buildings; 999,100 SF (40 Stories); New; Urban: Omaha NE. Limited sustainability and energy reduction measures deployed.
Iowa Association of Municipal Utilities Office and Training Facility (Hartl et al., 2002). Office Buildings; 115,000 SF; New; Urban, under 100k: Ankeny IA. Pre-LEED sustainability approach deployed.
Juvenile Services Center Design Challenges and Opportunities (Sullivan et al., 2005). Civic Buildings; 20,000 SF; New; Urban, under 100k: San Luis Obispo CA. Pre-LEED, but limited energy efficiency measures deployed.
Leazar Hall Renovation (Beaver, Coupland, Freeman, Kolepp, & Rydell, 2006). Colleges & Universities; 56,303 SF; Rehab; Urban: Raleigh NC. Limited sustainability and energy reduction measures deployed.
Planning Phoebe's Field (Lally, Cennamo, McGrath, Moulton, & Vernon, 2007). Parks and Public Spaces; N/A SF; New; Urban, under 100k: Blacksburg VA. No explicit mention of sustainability or energy reduction measures.
Strategic Air & Space Museum (Anonymous, 2003). Museums; 255,000 SF; New; Rural: Ashland NE. No explicit mention of sustainability or energy reduction measures.
The EpiCenter: Artists for Humanity (Ries, Berkolayko, deBarros, Pitzer, & Bokov, 2007). Design Studios; 23,500 SF; New (Brownfield); Urban: Boston MA. LEED Platinum.
Veterans Park Educational Campus (Black, Everhart, Johnson, & Wilson, 2001). Schools K-12; 411,108 SF; New; Urban: Wilmington NC. No explicit mention of sustainability or energy reduction measures.

For this ethnographic study, we collected and analyzed data from innovation and sustainability cases (artifacts) written by Architects in order to gain deeper insight into design culture and practices and to shed more theoretical light on PCN and FGA as discussed earlier. In addition, we aimed to deconstruct or determine if there were other less obvious or "surprise" practices by Architects enmeshed in the larger design process (standard model).

We used a textual content or discourse analysis and interpretive coding approach with the intent to generate useful meanings (Berg, 2009; Creswell, 2003; Saldaña, 2009). Each investigator, working independently, conducted

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interpretive readings of each artifact document then recorded overall impressions and created codes that captured important concepts, practices, and assumptions. Also, we evaluated each coded passage and denoted any particular metaphors or meanings evident in the passage (Fairhurst & Putnam, 2004). Next we conducted a series of meetings to generate a master list of codes and meanings. In areas of disagreement, which was more the exception than rule, we debated and developed new codes accordingly and revisited cases as necessary. During the analysis phase, we grouped similar codes into categories and generated a taxonomy with three constructs as delineated and discussed in the sections below.

Our ability to translate and generate meaning was perhaps facilitated by our own interdisciplinary backgrounds. We, both investigators, were each originally educated as Architects and had practiced architecture before becoming management scholars. While this domain expertise was useful, it required us to deliberately suspend and subordinate our own personal beliefs about the practice of architecture arising from previous experiences, and focus closely on the words and meanings imbued in each artifact (Fairhurst & Putnam, 2004).

Our method is consistent with that used by ethnographers, qualitative researchers, and discourse analysts (Fairhurst & Putnam, 2004; Ketokivi & Mantere, 2010; LeCompte & Schensul, 2013; Mantere & Ketokivi, 2013; Schensul, Schensul, & LeCompte, 2013). They have long collected and studied artifacts or objects as a means to gaining deeper understandings of a particular culture or subculture. They usually focus on material objects imbued with meanings and history that members of the focal culture regard as special and useful (LeCompte & Schensul, 2013). Artifacts might include tools, documents, foods, devices of play, decorative items, sacramental objects, clothing, structures, and other items (Chiseri-Strater & Sunstein, 1997). According to J. Potter (1996), ethnography in the form of textual or document analysis focuses on talk and texts as social practices and on the resources that enable those practices. For example, studies of racism have been concerned with the way descriptions are arranged in particular contexts to legitimize the blaming of a minority group (Jonathan Potter & Wetherell, 1988) and with the resources ("interpretative repertoires") that are available in a particular cultural setting for legitimating racist practices for example (Calas & Smricich, 1999; Wetherell & Potter, 1992). Discourse analysts have focused on issues of stake, accountability, relations, and process by reviewing how people manage pervasive issues of blame and responsibility (Edwards & Potter, 1993; Wodak & Meyer, 2009). Also, they have studied the way descriptions are put together to label actions and manage accountability (Wetherell & Potter, 1992).

Through our rigorous inquiry and analysis, we provide observations that contribute to an arising discourse about the nature of design culture and the phenomenon of its abductively generative and creative forces. We believe these contributions will stimulate debate and, ultimately, translate into potential systemic antecedents for change and innovation occurring in institutional

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universes replete with temporal constellations of networked organizations. Our research encompasses fourteen (14) independently crafted cases. This substantial pool of artifacts combined with information from other literature allows for enhanced verification, triangulation, and, as such, greater pattern recognition (Berg, 2009; Creswell, 2003; Saldaña, 2009). It is not within the scope of this paper to offer a comprehensive theory, but rather it is our intent to be generative and propose possible explanations in an area that has been principally underexplored. We aim to reveal potential meanings that, with further study and debate, might be useful for generating even more explanations or eventually reaching saturation and theory construction (Eisenhardt, 1989; Glaser & Strauss, 1967; Strauss & Corbin, 1998). We believe this work will eventually translate into systemic process antecedents for change and innovation.

Findings

Through our analysis of the case texts we identify three (3) change constructs prevalent in architectural practice and yet not present in management literature: *paradoxical cognition, network ensembles,* and *interpretive microprocesses*. The case narratives provide evidence that Architects explicitly or assumedly use these constructs throughout the entire design process. These are delineated in Figure 1 and described below.

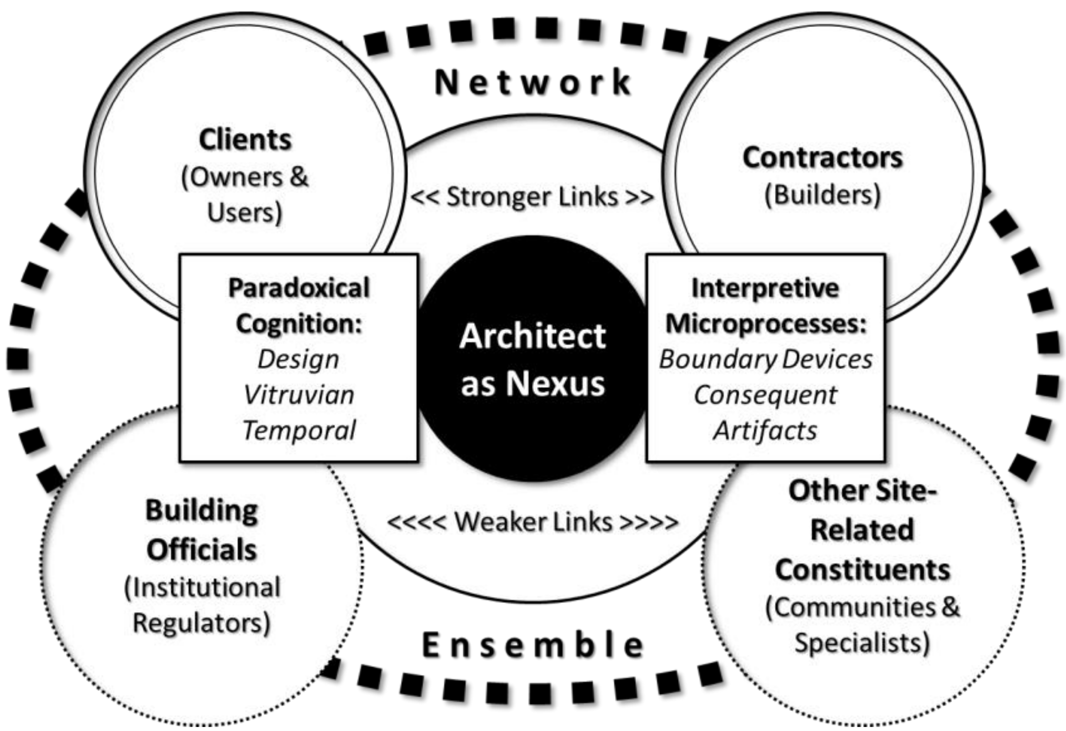

Figure 1. PCN, NEs, & IMs Diagram.

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Paradoxical cognition (PCN)

The first change construct is the cognitive style Architects deploy to generate novelty by addressing perceived contradictory or paradoxical intentions and information (Miron-Spektor, Gino, & Argote, 2011). Generally, PCN describes the phenomenon of decision-making that is focused on integrating conflicting and possible contradictory expectations (Smith & Tushman, 2005). The texts reveal that Architects iteratively ruminate over explicit and implicit paradoxes throughout the entire project process. PCN manifests through abductive reasoning, which is used to resolve tradeoffs among conflicting and seemingly contradictory needs and constraints. Architects view tensions arising from competing forces not as negative conditions or hindrances to resolutions, but instead as opportunities to enrich processes, improve designs and ultimately yield optimally balanced solutions. This text exposes the assumption evident in many of the cases: "It is evident that the nature of a renovation project presents numerous barriers in project completion. However, these potential problems have made the project that much more interesting for the involved parties." (Beaver et al., 2006, pp. 13-14)

PCN is an integral part of practice since Architects are educated to be normatively committed to creating shelter and protection. The tension between sheltered and unsheltered or inside and outside is a fundamental consideration. Expanding further upon this tension, architecture manifests the choices between technology and nature. This is evident in the tension between building and landscape, artificial light and sunlight, and conditioned air and fresh air. Each of these tensions presents positive and negative tradeoffs relative to constituents' perceptions and needs. Case evidence suggests that Architects iteratively generate several diverse options in seeking to optimally balance competing forces for each design situation:

> Often, however, the architect, faces difficult trade-offs. At the Juvenile Services Center, generous spaces were requested, yet the budget was limited. A normalized environment was desired, but safety and security could not be compromised. Site constraints limited the buildable area and created a public and a semi-private side to the project. All decisions had to be evaluated against a strict budget that had been established five years before the project was ready for construction bids. (Sullivan et al., 2005, p. 35)

Building upon the FGA literature described earlier, the case evidence suggests that FGA is an essential ingredient of the holistic thinking required for PCN and for achieving the optimal balance desired among competing project forces. FGA aids Architects to perform paradoxical cognition by prioritizing certain needs or constraints against competing needs and constraints. By viewing components as related foreground and background elements, Architects achieve the necessary isolation to define particular needs, constraints, and affordances while concurrently grasping the important connections, linkages and network relations

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relevant to the project. This yields a more holistic view of the project situation. Martin and Austen (1999) propose that for the integrative thinker, foregrounding and backgrounding variables is an active process of spatial manipulation akin to cutting and moving parts. Our research expands upon this understanding by identifying FGA as an essential cognitive attribute which, when coupled with abductive reasoning, enables Architects to perform paradoxical cognition. Architects achieve paradoxical balance through the ability to isolate competing needs and prioritize them as each project situation demands. The design of the architectural object is continuously seen against a background of constituent needs, history and historic narratives, site and context, technological constraints and affordances, institutional constraints and incentives, dominant archetypes, and the Vitruvian ideals. Moreover, Architects deploy FGA when determining metrics of success, design appropriateness, and aspects of time and pacing relevant to the project design process. For example, FGA is useful for determining when to proceed quickly, when to proceed slowly, and for prioritizing project tasks and objectives. Through our analysis of the case texts, three particular paradoxes emerge: Design, Vitruvian and Temporal. These paradoxes are explained below.

Design Paradox. This is the primary cognitive view adopted by Architects to understand and frame the competing forces of the design object, the design site, the design process, and the design constituents involved in creating and ultimately interacting with the object. The object is the architectural creation, usually a building, whereas the site is the context for the object and consists of both physical features (landscape, extant built environment, etc.) and communal patterns (the culture of local actors and groups, users, etc.). As discussed earlier, the legitimized and widely accepted codified design process is often referred to as the "standard model". Common constituent groups encompass both human actors and technological actants (Edgell, 2014; Latour, 2005). Actor groups include designers, engineers, clients, users, builders, suppliers, community members, and institutional members. Technological actant groups include Architectural and engineering firms, other business entities, community organizations, and institutional bodies. The case texts suggest that Architects are fundamentally concerned with balancing the tensions among object, site, process and constituents. Important variables that predict how these tensions might be resolved include firm identity type, treatment type (see table 1), and building type. While all seem to contribute, firm identity type is often the most influential lens through which Architects understand, interpret, and frame project situations.

Firm identity reflects the fundamental choices made by Architects to organize and pattern their firms as more *practice-* or *business-centered.* The Weld-Coxe (Coxe et al., 1986) typology uses these conceptions to frame a continuum on which firms locate their identities. The case texts support the wide acceptance of this identity model:

> It is difficult to describe Burt Hill as one pure type of

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> architecture practice. In certain instances they can be considered both business centered and practice centered. As a large firm they appear to be business-centered. Since there is a large staff to support, financial and business structure are always important. Burt Hill does pride itself on working in multi-disciplinary teams and draws upon the resources of each team member to meet client and project needs. For the majority of their work, however they fit into the practice-centered category, which shows its strength in service. (Hunter et al., 2001, p. 8)

In the cases, firm identity often predicts how firms define "quality design", determine criteria for project success, and, thus, how they resolve design paradoxes. Although the interpretation of "quality" as a value varies by firm and project, quality design is a dominant narrative in the case texts. Firms with *practice-centered identities* often conceive of and measure quality as an expression of Vitruvian ideals; these firms value robust iterative design processes that generate high degrees of novelty and pleasing objects. They emphasize aesthetics and the sensory and experiential satisfaction of actors over "service" values (e.g., functional, temporal, and economic concerns) (Moustafellos, 2014). For instance, greater design process emphasis often correlates with reduced firm profitability:

> Cannon Architects measure success primarily through the satisfaction of the client, as well as their delivery of exceptional design work, as befitting of the firm's identity and culture as a small, innovative, design-oriented firm. Although the project was less profitable for the firm, strict accounting measures in correlating hours worked and production are not stressed in the firm's organizational strategy. The architects most often would spend extra time refining ideas, redrawing numerous alternates to meet budget pressures, and upfront measurement and verification without additional fees. (Beaver et al., 2006, p. 18)

This emphasis on Vitruvian ideals and robust processes may also result in potentially higher costs to clients. However, clients are deeply embedded in design processes and in defining the project objectives and success criteria. Clients may ultimately choose to assume greater project costs for what they perceive to be the value of better quality objects: "Often when Mr. Livingood [the client] is questioned about the extra investment in their building he will respond, 'You can't put a price on good design.'" (Argyle et al., 2006, p. 8)

Conversely *business-centered* firms may be more willing to reduce their focus on achieving Vitruvian ideals and accept condensed design processes in exchange for greater firm profitability. The case texts indicate that this is usually achieved by decisions to better serve clients' usability, temporal, economic needs and, thus, reduce projects' costs or durations. For example: "Perkins Eastman believes it is more business centered than practice-centered. This

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means that the Client satisfaction is more important than architectural aesthetics." (Schlossberg et al., 2000, p. 6) Additionally:

> Clearly the use of an evolved, mature, prototypical design results in production cost savings, some of which can be passed onto the client. This strategy also results in a shorter design time frame and an earlier construction start. Established costing patterns also allow both architect and client to select materials with increased confidence that construction costs are under control. (Diercks et al., 2006, p. 30)

As these passages reveal, Architects seek to optimally balance the design paradox forces as a means to manifesting their perceptions of quality design. Although firms' definitions of quality vary, all case firms emphasize successful balancing of the tradeoffs among the design paradox forces. Furthermore, firms' intentions to find balance vis-à-vis the design paradox influences the development of the secondary paradoxes and other constructs discussed below.

Vitruvian Paradox. In creating design objects, Architects seek to balance potential contradictions arising from the Vitruvian ideals of aesthetic pleasure, functionality, and durability as described earlier. Again, firm identity, project treatment type, and building type seem to predict how architectural firms prioritize the three Vitruvian principles.

In the cases, practice-centered firms frequently emphasize aesthetics and novelty generation whereas business-centered firms tend to stress usability in the form of functionality and durability. Regardless of these prioritization differences, all firms highly value the iterative search for balance among the Vitruvian principles when designing objects; the normative goal is to create a "quality" or "best" designed object:

> The designer's responsibility is to effectively mesh solutions to the diverse design criteria into an overall "highest and best design." Design of a specific correctional project requires a mix of *theoretical* (e.g., spirit, beauty, and site adaptation), *pragmatic* (e.g., structure, mechanical systems, roof details, door schedules, and security system components), and *functional* (e.g., youth safety, direct supervision, and efficiency of operations) solutions. This combination of the theoretical, pragmatic, and functional solutions requires creative judgment in order to set and juggle priorities during design. (Sullivan et al., 2005, p. 36)

Firms that value aesthetic pleasure and novelty generation shift the balance of their choices toward the appearance and spatial experience of the building as well as their conceptual artistic interests. They focus on heightening constituents' emotional responses and satisfaction derived through sensory interaction with the object.

> As a firm, Cannon Architects are more focused on the practice rather than the business aspect of design. This focus on practice

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> resulted as a perfect match with the user group. As designers, they are focused more on good design, gaining experience, building client based relationships, and the desire to get the job done…They are ultimately more concerned with the end result and providing a good design than with profits. Steve Berg commented on the fact that Cannon Architects are comprised of architects who will not let a design suffer because of lack of fees. They strive for a great end product rather than let the design be governed by business realities. (Beaver et al., 2006, p. 21)

Firms that prioritize functionality shift the balance of their choices toward optimizing aspects of building usage and fulfilling constituents' utilitarian needs: "They hoped to gain as much square footage as possible, but had to find a balance between quantity of space and quality of space." (Beaver et al., 2006, p. 7)

Firms that prioritize durability shift the balance toward sustainability and, as such, the performance of the building over time and extending the life cycle of materials and construction assemblies. This includes greater focus on environmental impact and on achieving institutional incentives such as Leadership in Energy & Environmental Design (LEED) certifications by the US Green Building Council (USGBC, 2014). The case texts reveal that designing for durability in the form of LEED certification is often at the expense of aesthetic and functional considerations. Also, this requires firms to prioritize long-term over short-term views as explained in the temporal paradox section. In addition to endogenous project criteria including history, existing conditions and constituent interests, Architects deploy interpretive microprocesses such as boundary devices to interact with institutional fields. For example, they consider tradeoffs among potentially contradictory and complex exogenous health, safety, and welfare (HSW) regimes (e.g., zoning ordinances, general and building type-specific codes) that highly influence resolution of the Vitruvian principles. Two supporting passages include: "The Big-D corporate headquarters was an interesting blend of an historic preservation and LEED certified project. These two programs were, by their very nature, in opposition." (Argyle et al., 2006, p. 10); and "The highly regulated specifications for hospitals and labs creates [sic] difficulties in accomplishing LEED objectives." (Hedges & Elijah-Barnwell, 2005, p. 50)

Temporal Paradox. Throughout the cases, the temporal considerations of past, present and future states emerge as important variables. Beginning with the tension between past and present, many of the cases emphasize the importance of past history when considering present needs. Understanding the past is seen as an essential antecedent for enacting change since the past provides important asynchronous context and may define identities of constituents, organizations, sites, or objects. Architects often create novel object identities by drawing upon exogenous contextual aspects of sites while meeting

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current usability expectations as this text reveals: "The greatest challenge for LEO A DALY's design team was to create a landmark Tower that would assert the corporate identity of the Bank as well as reflect the specific history and urban elements that define Omaha." (Vidlak et al., 2004, p. 4)

Project treatment types influence temporal focus. For example, redesigning (rehabilitating or preserving) extant structures to meet present needs and the institutional constraints imposed for historic buildings induces greater project locus on the past. However, the case Architects habitually view this tension between past and present not as a constraint, but often as a source for inspiration, novelty generation, and innovation. Reinforcing texts include: "Burt Hill's intent in the project design was to provide a space for Carnegie Mellon that would meet the needs of the H&SS department, while also being sensitive to the existing architecture of Hornbostel's original design." (Hunter et al., 2001, p. 14); and "Innovation in design is contributed [sic] to Cannon Architect's dedication to serving the unique character of Leazar Hall. What is most successful is Cannon's ability to connect the past with the current design aesthetics." (Beaver et al., 2006, p. 14)

Shifting to present and future states, significant tensions arise from envisioning long-term sustainability while satisfying short-term gains. Common in the cases are situations wherein long-term desires for extended building life and usability often conflict with more immediate desires for reduced construction costs: "Complicating matters even further is the question of balancing initial (construction) versus life-cycle costs (and benefits)." (Sullivan et al., 2005, p. 36)

Additionally, the cases reveal that tensions arise from clients' competing desires for objects that provide certain features and usage configurations while being readily able to accommodate future changes. These desired features and usage configurations often impede future flexibility. Furthermore, this gives rise to conflicts between the competing narratives of current state "completeness" versus "incompleteness" (Raghu Garud et al., 2008). In the cases, the challenge for Architects is to effectively design the object for present needs and degrees of project completeness in ways that conceptually and physically accommodate both anticipated and unknown future expansion and change. Path dependencies are created; through strategic design decisions, Architects and others attempt to impose order on ambiguous and uncertain future states. The ambiguity of future needs may include organizational change and growth, contextual change of the site and surroundings, and instructional changes such as legal and policy shifts as the following text exemplifies:

> From the beginning of the project, the SAS Museum Board stated that the structure for the new museum must be expandable. To this end, the hangars were designed with a one-way structural system, allowing them to extend further out into the landscape in a linear fashion. (Anonymous, 2003, p. 16)

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Network ensembles (NEs)

The second change construct that emerges from the case texts is that Architects function through the use of distributed and embedded innovation agency (Edgell & Vogl, 2013; R. Garud & Karnøe, 2003). In particular, they arrange and work through networks of highly heterogeneous actors before, during and after the design process. Case evidence suggests that temporal ensembles of diverse actors and technological actants (e.g., interpretive boundary devices and artifacts) are important. Ensembles collectively function to facilitate communication (use of boundary objects) and distribute paradoxical cognition that improves governance and decision-making by reducing the incidences of judgment biases (Liedtka, 2015). Throughout the cases, the quality of the final design object is regularly attributed to the quality of the associated networks.

Architects and influential constituents arrange temporal project networks that are composed of four dominant and differentiated clusters: architectural firms (designers), clients (owners and users), contractors (builders), building officials (regulators), and other site-related constituents (communities and specialists). Architects have institutionalized and codified robust understandings of their own roles as well as key project archetypes such as “client” and “contractor”. Furthermore, they have developed boundary devices such as “AIA contracts” which specify clear and widely accepted expectations for these strongly-linked relationships. These effectuated agreements deliver relational stability while enabling improvisation and novelty generation by the ensemble.

Based on the case texts, we characterize the relational links (see Granovetter, 1973) among architectural firms and clients as usually *strong*. The links that flow from Architects and clients to contractors appear to be *strong to medium.* Lastly, the links that flow among Architects and various sub-contacted specialists (engineering disciplines, etc.), component producers, communities, and institutional representatives may be characterized as highly flexible and *typically weak.* With Architects as nexuses, these complex mixes of strong, medium, and weak ties seems to enable ensembles to be robust, stable, and integrated while being adaptable, differentiated, and temporal.

Network ensembles are essential for the design process. Architecture is a multi-disciplinary field that by necessity requires collaboration. Given the complexity of buildings and sites, Architects need access to enormous amounts and varying domains of knowledge. They gather this information from education, experience, and networks of differentiated collaborators. Project and client needs for robust heterogeneous information often determine firm structures and, to a certain degree, patterns or culture. Many of the case firms use internal “studio” structures (as defined below) to enable distributed power sharing and a more fluid, adaptable composition of project teams to optimize the mix of expertise. The studio configuration allows members to focus on particular aspects while grasping the larger unfolding design process: “The firm’s structure of multi-disciplinary teams and in-house consultants identifies the firm as one that can provide distinct solutions to each client’s problems.” (Hunter et

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al., 2001, p. 7); and,

> As an office, Cannon Architects are structured as a design studio. All aspects of the office structure are loosely defined. There is an intentional lack of formal organization. … There are no departments within the firm that specialize in any portion of the design process; rather, all employees are expected to participate in all aspects of the design process. (Beaver et al., 2006, p. 20)

Porous and malleable firm boundaries enable the flexible formation of complementary arrangements, usually on a weakly-linked project basis, between architectural firms with differentiated building or treatment type experience. These complementary relationships are identified as enabling experimentation, greater novelty generation, and ultimately innovation. This passage conveys the perceived nuances associated with this condition: "Finally, the nature of this project and of the firm itself is innovative. Clearscapes is a collaboration between an architect and a sculptor, an arrangement that lends itself to exploration and experimentation." (Anonymous, 2000, p. 26)

This creates more fluid, dynamic and responsive relationships that are an important factor in creating the necessary collaborations for achieving project objectives. These temporary and weak relationships may be between a firm and individuals or sub-contracted specialists or between architectural firms. To enable these dynamic and extensive ensembles to function as an integral whole, Architects assume the role of project nexus. Architects serve as mediators among clients, contractors, specialists, regulatory representatives, and communities and advocate for design coherence and fidelity as well as the health, safety, and welfare of the general public. Aspects of the coordination function emerge in these excerpts: "In this process, the architect has traditionally been recognized as the coordinator of the complex team assignment." (Sullivan et al., 2005, p. 35); and "Project manager Steve Schuster often found himself acting as mediator, trying to build consensus, or even playing the part of 'bad guy', telling one or the other of the clients, 'No, we simply can't do that.'" (Anonymous, 2000, p. 7)

Although Architects mediate network interests, the case evidence suggests that they use participatory power sharing practices and in many instances seem to act more as coaches, facilitators, and stimulators to ensure high degrees of information flow throughout the ensemble.

Interpretive microprocesses (IMs)

The third change construct observed in the cases is what we term, Interpretive Microprocesses (IMs), which are diverse technological actants in the forms of boundary devices (Fenton, 2007; Fox, 2011) and consequent artifacts (Hall-Andersen & Broberg, 2014). IMs not only enable the emergence of heterogeneous and even conflicting understandings, but also allow for the morphing of these malleable understandings into more homogeneous meanings.

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These eventually become congealed as agreements that are mostly, if not entirely, shared by ensemble constituents. Boundary devices (BDs), similar to boundary objects, are named entities which represent material or virtual knowledge microprocesses that enable exchange, translation, interpretation, and navigation across cultural and language boundaries which may act to separate various constituent communities as well as institutional representatives (Edgell & Kimmich, 2015; Fenton, 2007). We have adopted the word "device" instead of "object" since device is more consistent with the terminology evident throughout the case texts. Chief characteristics of BDs include high mutability for ease of understanding and use by differing communities combined with certain degrees of embedded fixedness to maintain fidelity to a particular purpose (Fox, 2011). While BDs are commonly found in other design literature thereby implying importance and standardization, the cases indicate that Architects also craft in situ custom BDs for localized conditions. BDs are interesting since they enable localized heterogeneous communities customarily bounded as a *network ensemble* to collectively transcend constraints arising from vernaculars and, as a result, to ideate, improvise, and ultimately develop common understandings. Generally, BDs take diverse conceptual forms, from repositories to communities of practice to strong archetypes to weak standards with degrees of variability (Carlile, 2002, pp. 451-452; Fox, 2011, p. 74).

In the case texts, we observe emergent clustered repertoires of BDs, with conceptually similar purposes, which become the basis for our typology that includes five categories: arranging, immersing, determining, conveying, and evaluating. Arranging BDs are useful for reaching understanding about various aspects of *NEs* functioning during the *programming* phase. Immersing BDs are useful for aiding *PCN* and gaining insights during the *programming & schematic design* phases. An example of an immersing BD is the "paradox cards": "This inexperience gave rise to the paradox cards, a method by which the museum group could compare opposite positions on a number of design issues and decide where they would like their building to fall on the scale between." (Anonymous, 2000, p. 13)

Determining BDs are useful for enabling *PCN* and arriving at critical design decisions and commitments during the *schematic design, design development, & construction documents preparation* phases. Conveying boundary devices are useful for transmitting fixed meanings to distant (e.g., weakly linked) project participants and various other aspects of *NEs* functioning during the *construction documents preparation & construction administration* phases. Lastly, evaluating boundary devices are useful for reflective sense-making about completed projects in support of *PCN* and *NEs* functioning during the *post occupancy evaluation & programming* (for other future projects). Although beyond the scope of this paper, details for specific boundary devices in each category are available from the authors.

It is important to note that although these categories appear to be discrete, the borders between clusters are fuzzy and overlapping; a particular object

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might shift between clusters depending on how users deploy it during a particular episode. The BD, charretting, demonstrates this nuance since it appears in both the immersing and determining clusters. As described earlier in the paper, Architects use charretting for the purpose of gaining insight into constituents (immersing) and ideation (determining).

While fluid BDs enable exchange, interpretation, and the development of shared understandings, often communities or particular actor coalitions reach agreement to ascribe higher degrees of fixedness to certain emergent meanings. As a result of interactions facilitated by deployment of BDs, constituents produce and disseminate artifacts. However, particular types of artifacts that we have termed "consequent artifacts" or CAs are outputs with clearly defined content that are intended by participating communities to fix or freeze meanings and particular knowledge. Usually these CAs are then used throughout the remaining phases of the larger standard model process with the intent to transmit stable meanings to other more distant actors and communities, perhaps separated by time, proximity, or power boundaries (Hall-Andersen & Broberg, 2014). For instance, charretting and the acts of creating visual representations such as sketching, modeling, and prototyping are *determining* boundary devices. These particular BDs are used by Architects to collaboratively engage various project constituents by stimulating divergent ideation which ultimately leads to accord about project design intentions, concepts, and particulars:

> With hundreds of sketches and pages of research, the HDR team had to layout visions of the future. Beginning with 101 programs (prioritized as high, medium or low), the HDR team gave business owners, developers, residents, and the city of Omaha several ideas to improve the area. (Hedges & Elijah-Barnwell, 2005, p. 47)

However, upon reaching discursive agreement, ideational convergence, or coagulation, certain sketches or visual representations (usually latest iterations) are converted to CAs by Architects and others with designations such as "final" or "approved" and may contain the signatures of the various participating actors as normalizing symbols. These CAs become frozen representations of microprocesses and encapsulate meanings with high degrees of fixedness and, thus, greatly reduce possibilities for further improvising, interpretation and mutability. Constituents who create CAs do so often with the intent to temporally guide, with fixed meanings, other actors through the next phase of the standard model process (which is an arranging BD) or to signal certain fixed impressions to particular groups: "Sketching ideas is a means of communication that not only impresses the audience but also develops a confidence in the expertise of the design firm." (Diercks et al., 2006, p. 19)

It is important to discuss the dynamic and nuanced causality inherent in the relationship between BDs and CAs. The cases generally indicate that latest iterations of BDs often become or lead to the formation of CAs. However, the

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cases also provide further evidence suggesting that it is possible for actors and communities to unfreeze CAs and, thus, return them to being active BDs. Furthermore, BDs exist that are used specifically for this process of unfreezing a CA. At the project level, change orders, errors and omissions insurance, and bid addendums, all conveying boundary devices, are deployed by Architects to gain constituent acceptance of the re-introduction of ideation into standing CAs such as construction documents and agreements. For instance: "This budget increase placed Clearscapes in the interesting predicament of adding previously cut amenities to the building during and after the bid process. Clearscapes made these improvements through bid addendums." (Anonymous, 2000, p. 23)

At the institutional level, change is made possible through the use of devices such as variances (conveying BD) which induce institutional regulatory flexibility by using discursive practices to alter extant codes and zoning regulations (Diercks et al., 2006, p. 15).

Discussion and conclusion

Our research reveals that Architects not only use the codified standard model to effectuate change and innovation, but also deploy less obvious practices, devices, and process constructs. The case texts reveal that the process of designing and constructing a building requires inordinate amounts of information and complex decision making. It may be that Architects overcome this information and decision-making challenge by deploying the three constructs described above to enable distributed cognition (Perry, 2013). Actors may use PCN to stimulate a range of remote information associations in the mind thus educing more information than would be otherwise available. This may be especially powerful when orchestrated across several NEs actors.

Furthermore, BDs such as charrettes and prototyping may assist with information collection by enabling not only verbal or language-based information stored in the brain, but also non-verbal, gestural, or visual information (Fischer-Baum, Dickson, & Federmeier, 2014). While NEs engage and focus more actors, the use of IMs may amplify the amounts and kinds of information flowing from individuals thus increasing heterogeneity and enhancing novelty generation. Systematically, all three constructs collectively may amplify the accessing and processing of heterogeneous information which reduces risks of decision-making biases such as narrative fallacy and confirmation bias (Liedtka, 2015).

The findings also suggest that Architects achieve novel change, in universes of networked organizations and normative logics, by framing and navigating paradoxes. Technological actants such as IMs offer the possibility for discursive interactions that lead to eventual shifting of schemas and the acceptance of novelty. The cases reveal that tensions arising from constituents' conflicting affects towards order and randomness are important antecedents for change and frame much of the design process—a reflection of the ambiguity and uncertainty present in design projects. To successfully navigate ambiguity,

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uncertainty, and assume intrinsic risk, Architects deploy iterative working methods enabled by IMs. Furthermore, project evolution and change are expected, embraced and codified through architectural practice norms.

While our investigation reveals that the case Architects apply a range of nuanced methods for achieving change and innovation, this qualitative research has limitations. Interdisciplinary research is challenging due to discipline differences in vocabulary and research methods. In addition, while exploratory ethnographic narrative and discourse analyses are useful for generating potential meanings and explanations, additional empirical field research is needed to verify these explanations, to better infer causality, and to arrive at a generalizable theory. Researchers might want to corroborate our constructs and generate additional constructs by conducting detailed interviews with large numbers of Architects. This might lead to meaning condensation, saturation, and theory construction which would be useful for testing purposes.

Despite these limits, we have endeavored to provide useful insight for other researchers and practitioners. Policy makers may find our research useful for stimulating conversation about social and institutional change and for gleaning deeper insight into the discursive means by which policies may be changed to enhance innovation. For practitioners in firms, these constructs might be useful since they provide a language for discussions and advocacy about governance, creativity, innovation, and change. This information sheds light on a previously underexplored area and suggests that novel change and innovation occur in “universes” when heterogeneous ensembles of human and technological devices interact through both structured and improvised interpretive microprocesses. We hope our words have the power to sensitize varied constituents so that they become more aware of the complex and nuanced relationships among design culture, abductive reasoning, and innovation.

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