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FINDING CONNECTIONS BETWEEN DESIGN PROCESSES AND INSTITUTIONAL FORCES ON INTEGRATED AEC TEAMS FOR HIGH PERFORMANCE ENERGY DESIGN

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ABSTRACT

Engaging the need to better understand the problems of high performance energy design in AEC collaborative practices and delivery methods, this study tested a schema that differentiated between the micro level of everyday design decisions, the meso level of project organization that guides project delivery, and the macro level of institutions—professions, disciplines, and firms—within which AEC practice takes place. Based in observations and interviews of two large projects in a U.S. architectural firm, we used a comparative case study to develop a series of analytical themes that located where issues of meso and macro level forces impacted micro level energy design decisions. This study found that the architect's disciplinary vision and project management styles were very influential over energy design accomplishment, while firm attitudes promoting high performance design had little effect. Overall, we found no example of micro level design decisions that did not implicate some type of meso or macro level influence. This suggests that industry guides emphasizing technical solutions achieved at the micro level are not adequate for the needs of evolving AEC integrated practices.

KEYWORDS: Energy design, integrated practice, institutions, structuration

INTRODUCTION

As high performance energy design increasingly becomes central to the early design phases of new building projects, issues in collaborative communication and team decision-making are beginning to appear as impediments to the work of architecture, engineering, and construction (AEC) integrated project teams. This is a significant problem since we know that there is growing evidence that the predicted energy performance of new buildings is often not being realized in post-occupancy measurements (Turner & Frankel, 2008), that there can be a "mismatch" between the design of a building and its predicted energy performance (de Wilde et al., 2014), and that the thinking and decision-making processes of engineers and architects are not always compatible with computational tools typical to energy design (de Wilde et al., 2002; Grinberg & Rendek, 2013).

Seen in collaborative delivery methods like Design-**B**uild and Integrated Project Delivery (IPD), AEC integrated project teams are where architects collaborate with engineers, builders and owner representatives to co-produce building designs. In the attempt to realize high

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performing energy design goals, integrated teams can struggle from tensions between knowledge sharing, design communication, integrated thinking processes, and how integrated AEC practices are structured. Many researchers have found that integrated AEC teamwork involves tensions that are particularly challenging; collaborative teams are situated in an adversarial culture based upon longstanding disciplinary histories, they are not well composed to produce shared knowledge, and they are not well suited to incorporate or leverage new technologies (Cicmil & Marshall, 2005; Dossick & Neff, 2010; Dossick & Neff, 2011; Smyth & Pryke, 2008). These issues are conceptualized by social theories that have, until recently, been often lacking as foundations for AEC research.

The tensions that occur in integrated AEC teams run between the *micro levels of design thinking processes*—the activity of individuals and groups considering project variables, analyzing them, and then synthesizing variables into potential solutions—and the *macro level of institutional forces*—the institutions (Scott, 2014) like AEC professions, disciplines, and firms that guide practitioners in their actions and that operate from institutional logics (Thornton et al., 2012). Between the micro and macro levels is the *meso level of project organization*—the shared work and communication structures defined by the interdisciplinary routines that guide project delivery. The interrelationships between these micro, meso, and macro level effects are described by the theory of *structuration* (Giddens, 1979; Barley & Tolbert, 1997). In the problems facing high performance energy design, industry solutions to date have been offered almost exclusively at the micro level of technical design details. When energy design is seen within the context of integrated practice, it becomes clear that a whole range of institutional phenomena at the meso and macro levels are likely being missed.

In this study, we aimed to test the efficacy of the schema of micro, meso, and macro level effects through the theory of structuration on high performance energy design projects that use an AEC integrated practice delivery method. Based in observations and interviews on the energy design process of two large projects in a U.S. architectural firm, we used a comparative case study method to develop a series of analytical themes that located where issues of meso and macro level forces impacted micro level energy design decisions. By finding examples of where meso level project structures and management as well as macro level institutional forces like professions impede energy design accomplishment, we are able to show that there are limitations to the industry focus on micro level technical solutions to energy design. The schema of micro, meso, and macro levels offers an effective method by which the collaborative complexities of high performance energy design within contemporary AEC integrated practices can be understood and prescriptive solutions offered.

PROBLEM REVIEW AND LITERATURE

High Performance Energy Design

High performance energy design involves the mechanical systems, detail assemblies, and operational control strategies designed by an AEC team for a new building as measured by the site energy consumed by the building's operation and occupancy. Various configurations of building components are often simulated by energy modeling during the design process in order to estimate and analyze the likely energy performance. These modeling simulations have become emblematic of high performance energy design, and they are generally considered most effective when done at the earliest phases of the building project (Bambardekar & Poerschke, 2009; Torcellini, et al., 2010). Energy design is also impacted by the expertise, skills, and judgment of the AE design team. The holistic integration of AE design team expertise and energy modeling is seen as a significant issue for achieving high performance energy design (Aksamija, 2010; Bazjanac et al., 2011).

High Performance Energy Design in Integrated AEC Teams

In the research to find solutions to the "performance gap" between building energy use predicted by AEC teams during design and the measured energy use of the building post-occupancy, there are three main project phases where problems could be located: design, construction and handover, and occupancy and operations (de Wilde, 2014:42). The focus of this paper and the research that supports it is located in *the design phase*. In the work that traditionally has characterized the design phase, architects and engineers take shared information about the project requirements and work independently to produce building design components (Grinberg & Rendek, 2013). In contemporary design and construction, this division between architectural and engineering building content has been brought back together in collaborative delivery methods like Design-Build and IPD. Integrated practice is seen to be among the most powerful design phase project organization to ensure that high performance energy design is realized by the AEC team (Mollaoglu-Korkmaz et al., 2013). This paper and its research study focuses on the problem of *achieving high performance energy design in integrated AEC teams*.

Since the advent of "the practice turn" in organizational and project management research (Nicoloni et al., 2003), an increasing number of AEC scholars have probed the actual practices of intra- and inter-disciplinary collaborations by broadening the social content of AEC research (Chinowsky, 2011; Cicmil et al., 2006; Levitt, 2012). Among the key features of this social content are the organizational, disciplinary, and professional institutions that characterize AEC practice and enable—as well as encumber—its activities. To study energy design within these new forms of AEC collaboration requires closely observing the activities of AE practitioners, gaining their reflections on integrated design activities, and seeing all of this evidence through the structure of larger institutional forces.

Micro, Meso, and Macro Level Effects on AEC Practitioners

The forms of energy design work done by architects and engineers are not invented for each project; they are inherited from habits of workflow and communication in firms, norms of project definitions, phases, and goals shared across an AEC team, and the impact of disciplinary education and professional standards. These multiple forces that act upon AEC integrated design are not always visible to the practitioner or the researcher. A useful construct to organize these conditions is the three-level schema used in the social sciences and organizational studies where phenomena are ordered as micro, meso, or macro level; "from the very micro (what people say and do), to the meso (routines), to the macro (institutions)" (Miettinen et al., 2009:1309). For our purposes here, we assert that integrated AEC practice involves the micro level of everyday design decisions taking place individually and in teams, the meso level of project organization and shared interdisciplinary routines that guide project delivery, and the macro level of institutions—professions, disciplines, and firms—within which AEC practice takes place.

For high performance energy design, the schema of micro, meso, and macro levels provides a structure of analysis for forces that might make design integration more difficult. Through this multilevel schema, we not only have a means by which to investigate conflicts of integration *across* disciplines, but we also have a structure that works to recognize forces that might be working *within* disciplines.

Limitations of Energy Design as a Problem of Technical Implementation

Given that the difficulties of realizing high performance energy design have been seen as a function of AEC team integration and the conflicts and tensions of disciplinary forces operating at multiple levels of impact, it is surprising to find that the meso and macro levels of energy design practice are rarely identified as a location for improvement. As it turns out, most of the guides that offer solutions to the complexities of energy design assume that the problem is largely one of technical implementation at the micro level. Integrated AE design processes are mostly left unaddressed (de Wilde, et al., 2002). Guides written to assist integrated teams generally offer specific detail assemblies and systems components across building categories like envelope, lighting, HVAC, and plug loads. For example, ASHRAE has produced a series of books called the Advanced Energy Design Guides (AEDG) that provide prescriptive recommendations, case studies, and technical examples to improve energy design performance by 30 to 50 percent over ASHRAE Standard 90.1. The AEDG series has wide industry acceptance (Liu & Athalye, 2015). Similar guides exist for architects (Kwok & Grondzik, 2012) as well as particular types of owners like the federal government (NRC, 2011).

However, very little of the content in these prescriptive energy design guides addresses the integrated AEC team issues at the meso and macro levels as we have outlined. While these technical guides illuminate many energy systems details for practitioners at the micro level of design decisions, they offer relatively little in terms of a deeper understanding of the tensions arising from integrating AEC practices.

Potentials of Energy Design as a Problem of Integrated Practices

Acknowledging the difficulty—as well as the necessity—of integrated practice in producing high performance energy design, AEC researchers have seen that the issue can be understood by interrogating the integrated and collaborative environment of the AE design team and the professionals that comprise it. De Wilde et al assert that "the selection of advanced building components can only be studied in the context of the information flows, expert interventions, decision-making culture and group dynamics" of intra- and inter-disciplinary activities (2002:192-93). De Souza reiterates this idea by saying that the challenge of understanding energy design "seems to be a matter of interdisciplinary research in which critical thinking and reflections on knowledge, worldviews and other theoretical aspects involved in the two [AE] professions need to be discussed beyond empirical studies and practical propositions" (2012:113). Unlike the technical guides seen so pervasively across AEC practice, these researchers are suggesting that the effort of high performance energy design is perhaps best understood through a closer examination of the constituent disciplinary work norms within integrated AEC teams and their interactions across energy design processes.

THEORY

Micro, Meso, and Macro Levels Through Giddens' Structuration

The interrelationship of micro, meso, and macro effects is a conceptual position first argued by Anthony Giddens in his *Central problems in social theory: Action, structure, and contradiction in social analysis* (1979). Giddens proposed the theory of structuration that aligned both the human actor and society in a structure that is "both the medium and the outcome of the practices that constitute those [social] systems" (1979:69). What was essential to structuration was how human activity was integrated with social structural forms. Most important for the study here, Giddens saw human activity and social structures as mutually constructed, a condition that he called the "duality of structure" (1979:69). In this sense, structuration theory argued that the micro level of human action and the macro level of institutions were inextricably connected because they were co-constructed. Any cogent understanding of either actions or institutions required an understanding of both.

In the AEC industry context, micro, meso, and macro effects can be seen to demonstrate features of being "both a product of and also a constraint on human action." (Barley & Tolbert, 1997:97) For example, the profession of architecture in the U.S. held for most of the 20th century that the contractual separation from constructors provided value to owners by protecting building projects from losses of quality or increases in costs (Cuff, 1991). These beliefs were in turn embedded in meso level project process routines that created linear authority and communication practices between architects, engineers, and contractors. These beliefs also bolstered pre-existing power structures at the macro level of architects as professionals. However, the burgeoning incorporation of digital tools and the persistent problem with construction productivity have since catalyzed a contemporary effort to forge closer links between architectural design and construction, a result of which is the growth of integrated AEC practice and the fragmentation of traditional architectural practice (Bernstein, 2010; Tombesi, 2010). As collaborative interdisciplinary teams and integrated contracting methods develop and gain broader acceptance, there are corresponding pressures for meso level project process changes that blur the project authority of architects and commensurate macro level changes to the architectural profession in terms of its traditional power and leadership. In this way, we see how micro level actions are subject to the forces of meso and macro structures but can have equally generative effects on reshaping those structures.

In this study, the model of interactions follows the concepts of structuration and shows design decisions as a function of micro, meso, and macro level effects (Fig. 1). The model diagram simplifies the much more complicated process of structuration interactions to address

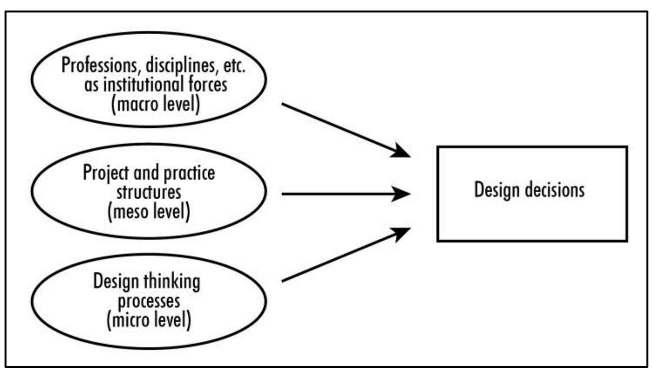

Figure 1. Model of design decisions as a function of micro, meso, and macro effects.

two exploratory questions. First, is it beneficial to hold some forces constant across an example of energy design activity to confirm that there are differences at the micro, meso, and macro levels? This question would imply limiting the initial analysis to practitioners within one AEC discipline and a single firm. Second, through such an inquiry, can we gauge the extent to which micro level design decisions properly characterize the activity of energy design for high performance buildings? This question would offer some perspective on whether the type of solutions the industry has thus far relied upon—technical guides—are addressing the problems of energy design at the right level of activity.

METHOD

This comparative case study is based in observations and interviews on the energy design process of two major projects from one U.S. architectural firm. The project teams for both buildings were different as were the design outcomes, but they shared the firm's overarching goals to be recognized for high performance energy design as well as all of the institutional forces that would generally influence design activities across projects. In this way, the two project cases had similar macro level institutional effects but different micro level design performance outcomes. The two projects were documented through 270 hours of observation and 14 semi-structured interviews with 13 project team participants. Field notes and interviews were coded with Atlas.Ti and interpreted through axial and selective coding, analytical memos, and weekly research team analysis meetings (Miles et al., 2014). Data collection and data analysis proceeded in parallel, and the two field researchers regularly discussed new data and interview results multiple times per week. Concepts and themes were co-developed through data matrices and case summaries. Analysis themes were driven by comparative consideration of data from other case studies in the data set and the professional knowledge and expertise of the engineer, architect, and energy design specialist on the research team. Coding themes for micro, meso, and macro effect identification were organized around the distinctions between discrete design decision activities, project level structures and management, and the larger macro forces that influenced activities and project structures through more general attitudes and beliefs.

Interview questions asked of participating team members were organized around stories of energy design aspects of the project work. Unstructured lines of inquiry were followed where participant answers suggested potential elucidation of meso level project structures like management processes, team goal integration, and disciplinary divisions. Macro level forces followed in the interview process included professions, disciplines, firms, and regulatory and governmental structures impacting energy code requirements.

DATA AND ANALYSIS

A Narrative of Energy Design Tensions in Practice

The study focused on the case comparisons between two building projects, Crestview and Towerland. Crestview was a large institutional building for a sophisticated owner with a large portfolio of facilities, and Towerland was a medium sized infrastructure building for a governmental owner. Both Crestview and Towerland were designed by OptiTeam Architects, a large international architecture firm offering design and planning services across a wide variety building types. OptiTeam Architects had an internal mission goal to be among the top international architecture firms achieving high energy and sustainability performance, and the firm had signed on to the Architecture 2030 challenge to design carbon-neutral buildings. To achieve these outcomes, OptiTeam Architects had instituted a number of initiatives across the firm. They had staff specialists that supported design teams in their work to achieve high performance design, they instituted project design reviews oriented to energy and sustainability design issues, and they kept online documentation on energy design goals and accomplishment through all design phases of every project. With these initiatives and a widely shared commitment to high energy and sustainability performance, the staff of OptiTeam Architects worked in a macro level institutional environment that structured meso level project goal setting, design decision-making processes, and project management strategies to advance strong micro level energy design outcomes.

Early in the study, we conducted parallel interviews that vividly showed two architects with different macro level interpretations of the energy design issues on the Crestview project. The differences were curious because the two architects were otherwise similar in important ways. They had both shared lengthy careers at OptiTeam Architects, they were steeped in all of the firm's habits of practice in a particularly complex market sector, and they shared a basic belief in the goal of realizing high energy performance. In terms of meso and macro level forces, these two practitioners were acting within a nearly identical context. However, it turned out that the two architects were operating under very different beliefs about what the operative forces in the project actually were.

The first architect, Brad, was responsible for project management for the Crestview team. The project used an integrated practice method for its team organization and design process. The other architect, Henry, was a specialist consulting with the design team to guide the achievement of high performance energy design. The Crestview project RFP had a stated energy goal that would be substantially lower than EUIs for similar buildings of its type. Having never seen an RFP in this market segment that included a high performance energy goal, OptiTeam Architects took that as an understanding that the Crestview owner held energy performance as an important project outcome.

The preliminary design work on Crestview was relatively difficult because of ongoing variations in project scope and budget. There was a tremendous range of energy systems put forward for consideration, which sometimes frustrated the technical members of the team. Per the project schedule, the AEC team prepared a concept proposal to be presented to the owner's group. At the project concept meeting, it was clear that there was a serious disconnect between the conceptual design and the ability of the owner to support high performance design strategies with an appropriate budget. There was an open discussion about letting go of energy goals altogether. Suddenly scrambling, the Crestview design team would have had to greatly limit the range of potential energy saving features to meet a much smaller budget while still attempting to achieve a level of operational building performance that wouldn't embarrass the firm.

Crisis of Micro Level Project Outcomes Influenced by Meso and Macro Effects

Brad and Henry were both interviewed the day after this difficult project concept meeting—an environment Henry called a "pressure cooker." Both architects were less guarded than they had been in previous interviews because some of the latent conflicts in the Crestview project had been brought out in the open. What was particularly notable about their reflections was how their differing perspectives on the micro level energy design decisions in the building concept were being driven by their conflicting logic propositions about the meso level project characteristics and the macro level institutional forces affecting the design work.

We can see these tensions through Brad and Henry's divergent thoughts on the original base building option and other alternative energy options presented to the owner. Henry had advocated for a design process that entertained a wide variety of energy system component options. Each set of options could be assembled with others to result in a range of EUI profiles. Henry believed that these options offered aspirational possibilities to the owner to improve their new building beyond the EUI originally specified in the RFP—a design that might lead to deep energy savings, innovative outcomes, and even changes in user protocols within the building. However, the benefits of Henry's position at the meso level of architectural project management made the micro level of actual design decisions much more complicated. For instance, the large number of energy systems considered by the design team meant that it was difficult to make an assessment and produce one set of systems that worked as a base building option. Henry admitted that it was difficult to aggregate energy system information to form a clear and workable base design. To Brad, this messy result was a function of a failing to "lead" the owner to a logical resolution of energy design choices. He felt that the design team had abrogated its responsibility to justify systems choices based on clear energy performance and investment payback, all of which would have clarified the base building option and simplified choices for the owner. At the meso level of architectural project management, Brad's positions were aligned with the normative macro level structure of "professions" where the architect is seen as the leader and gatekeeper for design communication between owner and design team members. In this macro level conception of architectural practice, the breadth of ambiguity of building design questions is controlled through the directed, narrowing activities of the architect. In contrast, Henry's macro level position suggested that project management had to allow for and even encourage the excesses and messiness of design thinking and creative team processes of the engineers and energy consultants beyond the architecture firm. Henry saw the macro level of professional responsibility to be much more about owner aspirations and the sustainability of the final project outcome.

What is valuable about this story is the way that it sets up the problem of finding a practical solution and next steps for the design team. Energy guides and the practical explanations of energy design process at the day-to-day micro level of design decision making wouldn't adequately deal with the chasm that exist between Brad and Henry at the meso level of architectural project management or at the macro level of their beliefs about the profession of architecture. When other data was subsequently analyzed from these same two interviews, we found other macro level conflicts between the two architects: in the economics of owner budgets and design firm profitability, the quantification of ambiguous formal conditions, and the hierarchy between environmental sustainability and architectural aesthetics.

Comparisons Across the Architectural Design Teams of Crestview and Towerland

Compared to the Crestview project and its specified EUI, the Towerland building project began with its owner not having a particular energy design goal nor desiring one. However, during the early design process, the design team worked with the owner's group to gradually develop a project narrative that involved a stronger relationship to the public and surrounding neighborhood community. Accomplishing high performance energy design slowly became a beneficial project goal. Supported by a number of internal and external constituencies, the energy goals on the project morphed from no savings beyond code requirements to a Net Positive design where the building was producing more energy than it consumed. The design team entertained a number of radically new technologies to gain energy savings. Even though the work to consider the possible energy systems was difficult, the design team shared an overwhelming sense of vision where they were allowed to invest their own expertise and innovation as part of the design work. In the end, the owner was completely convinced by the final design and the benefits they would gain from this dramatic shift in project goals.

Analytical Themes: Similarities and Differences in Micro, Meso, and Macro Forces

Considering data gathered from the project team members from OptiTeam Architects, the participants interviewed on the Crestview and Towerland building projects shared a number of macro level conditions. As members of the same architectural firm, they were familiar with the overall company goals of realizing high energy performance. In fact, a number of them viewed that mission as a compelling reason for their careers at OptiTeam. They all had architectural educations and backgrounds, and so they were immersed in the strong institutional forces engendered by their training and their profession. Holding these macro level forces constant allowed the analysis to differentiate more carefully between other effects elicited through participant interviews and observation.

Through the analysis effort to identify design decisions that exhibited qualities of micro level activities connecting to meso and macro forces, we were able to generate eight broad themes that emerge in the two projects and the two teams of practitioners. These themes identify different areas of influence that appeared to have impacted micro level design decisions and thus hold potential explanatory power about what higher level structuration forces might impact the successes—or failures—of high performance energy design. These themes included: the firm and high performance design, the practitioner and high performance design, the architect's vision and internal guide, energy and its rank in the hierarchy of design issues, the owner's priorities and influence, goals in project performance versus aesthetics, brokering knowledge across disciplines, and project management style. Some of the categories seen to be of most potential influence on micro level design decisions will now be discussed.

The Firm and High Performance Design.

Contrary to OptiTeam's strong vision of being an internationally recognized firm for energy design performance, the design team members from the two projects did not feel that the firm was responsible for their personal commitment nor the commitment of their project team to high performance energy design. One project architect summarized these feelings by saying,

> *"We don't have the sort of structure where you have this top executive leadership group saying 'Come on, guys, you got to push this.' It's not that. I mean, the culture encourages it, but teams are empowered to do what they need to do, plain and simple."*

Another team architect said that the firm had very high goals for building design performance but that most of the staff was aware that those goals were not strictly followed, and that "it's not like at the forefront of the project" for most design teams. Alternately, a project manager noted that the goals and vision of the firm, while not "altruistic," were connected to "a greater good" that "connects with my personal values." Overall, we saw that team members did not believe the firm was directly responsible for energy design accomplishment on their projects, and we did not see where the macro level institutional force of the firm's vision or directives were regularly impacting micro level energy design decisions.

The Architect's Vision and Internal Guide.

We saw that architects on both project teams had strongly positive beliefs on how their education and their discipline affected their priorities and vision in their design work. One architect said,

> *"We're designing things, building things, we're trying to inspire, we're trying to see that what is built is influential on people's lives. And that when you're really hitting it on all cylinders, that that happens and that's something that you feel a sense of pride in that work and people kind of life there, work there, play in those environments and it's an extension of our culture and who we are. So I think it's in some regards, very—it's embedded.*

Other architects shared this viewpoint, and it seemed particularly influential to how architects set up decision making processes for larger integrated teams. Non-architect project team members at OptiTeam shared in the idea that the team's design work was done in an attempt to improve the built environment. Overall, we hypothesize that the vision architects shared on how they practice was among the most powerful macro level institutional forces guiding micro level project design issues. However as we see through the next two thematic categories, this vision did not necessarily mean energy design issues.

The Practitioner and High Performance Design.

The architects on the two project teams did not generally accept that project design practices are—or should be—focused around high performance energy design. One architect argued that early design phases had to be focused on the more architectural issues of form and aesthetics as opposed to building systems and energy:

> *"I personally am not a big proponent of 'Let's start talking energy at the very beginning.' Clients don't want to hear that … I just first try to get their trust and then slowly introduce them into the ideas of other components."*

Another architect reiterated the belief both inside and outside the AEC industry that architects are focused on aesthetic issues—a powerful macro level institutional force of architecture as a profession and discipline (Cuff, 1991). This architect said that engineers had to "stick" mechanical systems inside buildings because architects generally conveyed the sense of "Don't bother me with your ideas because I'm the designer." The architects at OptiTeam didn't always do much to push back on this perception. When asked what work he did in relation to energy efficiency in buildings, one design architect bluntly responded "Zero." Considering all of the successful energy performance issues incorporated into his building design, this statement was not true. However, by suggesting he spent no time on energy issues, this architect meant to convey that energy design and energy systems played a subservient role for him in the hierarchy of issues involved in the design of buildings. We saw that these strong beliefs of architects—holding high standards of aesthetics and providing quality spaces for inhabitation—were sometimes at odds with other project concerns like energy design. However, the participants we interviewed were aware of the contradictions and were often seen to be working hard at incorporating performance issues into project design decision processes. Both the designs of Crestview and Towerland successfully met or exceeded the project's energy goals, an outcome that was produced by the attention and diligence of the architects on the integrated team. There seemed to a disconnect between what architects said about the relative importance energy design and what they were actually doing to achieve it within the integrated project environment.

Project Management Style.

This thematic category recognized some of the differences in how the two projects were managed and the beliefs at the center of what made energy design issues either easier or more difficult to pursue. When asked what guidance OptiTeam Architects provided project managers (PMs), it appeared that there was little direction coming from the firm on how project management was organized or executed. Like most architecture firms of similar size, OptiTeam had a variety of handbooks and project-based management documentation systems in place for PMs, but those generally codified project data gathering strategies as meso level practice routines. The details of project team organization, owner relationships, and day-to-day project management details were left to each individual PM's knowledge, skill, and experience.

Given the similar firm context within which each was practicing, the differences between the two project managers' styles were quite broad. The PM for Crestview employed a management style characterized by fairly autonomous team member activities punctuated with regular group meetings to align design issues, make decisions, and communicate owner directives. This style would be one recognized by most AEC professionals who have worked under traditional architectural project management. The PM for Towerland didn't organize his project particularly different from Crestview, but he did craft his management strategy on a more person-oriented basis. He first cultivated team member investment in the project by listening to their ideas and allowing people to own particular aspects of the building design. The eventual outcome of this managerial motivation was an extraordinary amount of innovative energy design research by the architectural team. Nearly every team member reported that they had investigated numerous alternative systems and assemblies—most never used before by the firm—to reach the Living Building Challenge goals that were guiding the project's Net Zero outcomes. The Towerland PM said that he found traditional management where the PM exercised too much of a leadership role "an impediment to a good project." Everyone who worked under the Towerland PM felt that he was a particularly gifted project manager. One architect said that he felt that he had learned more on this particular project and grown more as an architect through the PM's efforts. The Towerland PM also had the belief that a deep understanding the owner was a necessary investment before putting aggressive or aspirational energy design goals in front of them for consideration. He stated that he didn't think that the OptiTeam energy and sustainability support staff always understood that an owner's representative did not come to energy design discussions with the same knowledge or aspirations that members of the design team might. He felt it was more effective to bring the owner along by showing them the performance and cost savings from a series of modest energy design improvements rather than start the project from overly aggressive goals and underexplored design propositions.

Like the earlier story of Brad and Henry in the Crestview building project, the project managers on the Crestview and Towerland projects shared many of the same meso and macro level structuration effects. Yet their practices showed differences that appeared related to the outcomes of their projects. The Crestview PM had a more difficult path to realizing the original EUI goal on his project, but he and his team eventually achieved it. The Towerland PM employed a more team-member centered management process that allowed for a dramatic change in the energy performance of the design to Net Positive. Through this accomplishment, he also produced a visionary new project narrative for the owner: a community-responsive public infrastructure project that demonstrated its commitment through energy design.

DISCUSSION

It is clear that new research strategies are necessary to investigate the complex collaborative environments and work practices of integrated AEC teams. This is especially important considering the how valuable integrated AEC teamwork is to improving the energy design performance of new buildings. Prescriptive solutions to the problems of high performance energy design offered at the micro level have left problems about integration at the meso project level and macro institutional level underexamined. This study engaged these more nuanced conditions that effect the collaborative work of integrated AEC teams. By using the analytical construct of micro, meso, and macro through the theoretical logic of structuration, we have some initial lessons that might influence similar research work in the future.

From our first exploratory question, our data does show that energy design issues at the micro level of design decisions are affected by meso level project organization and macro level institutional forces in integrated AEC teams. Minimizing differing forces by holding variables like project, firm, and discipline constant, we could see how the micro conditions of energy design weren't the only location of conflicts and tensions that might affect the outcomes of energy design. In our study, we saw that the architect's vision and internal guide at the macro level was a very strong force over how architects think and act. Connected to this finding was the somewhat counterintuitive outcome that the commitment of OptiTeam Architects to design high performance buildings didn't seem to translate directly into attitudes or actions of the architectural staff. Using the co-construction process from structuration theory, we might propose that either the assumption of authority of an architectural firm over the attitudes and performance of its staff is somewhat weak—implying that the macro level institution may be undergoing structural changes from micro level actions—or that the strength of another institution, namely architecture as a discipline, is simply much stronger than the actions of a firm. Since qualitative studies like ours suggest generalization at the level of theory, we feel that macro level institutional forces involved in energy design improvements need to be carefully assessed for competing macro level forces before identifying potential areas for change. We also saw that there may be important locations for energy design interventions at the meso level of project management. Seeing the radical improvement in the energy performance of the Towerland project across its design phases, it appears that shifts in project management methods may work to improve energy design outcomes. The management methods used by the Towerland PM that incorporated staff commitment and investment in energy design research as well as cultivating an evolving aspirational project narrative with the owner seem to have to be particularly effective. The architectural staff on the Towerland project felt that the spirit of innovation cultivated by the PM made it easier to deal with the integrated AEC team decisions required to achieve high performance energy design. It may also be important to note that the Towerland project was not considered particularly high profile by OptiTeam Architects at first. This may have allowed the Towerland PM more leeway with his staff-oriented management method. Had the PM been running the project with methods that were beyond the capacity of the firm to support him, he likely would have had to endure challenges because of a perceived assumption of additional risk. Again at the level of theory, we feel that changes desired for improved energy design at the meso level of project management should be considered against macro level institutional forces that might find the changes problematic in terms of risk or other potential outcomes.

Our second exploratory question asked to what extent micro level design decisions characterized the activity of high performance energy design. While that exact answer must await further data collection and analysis, what we have tentatively found is that the impact of meso and macro forces on energy design accomplishment is quite profound and comprehensive. Supporting the theory of structuration as a whole, we found no example of micro level design decisions that did not implicate some type of meso or macro level influence. The story of Brad and Henry's differences as a sort of "crisis of meso and macro effects" offered very clear evidence of how larger forces could disrupt the ongoing work of energy design on an integrated AEC team project. While a proportional measure of where prescriptive energy design solutions should be aimed between micro level and meso/macro level forces does not yet exist, we feel it is fair to say that the emphasis of industry guides on technical solutions at the micro energy design level are not adequate for the needs of evolving integrated AEC practices. As this initial study has shown, there is much ground yet to be studied and explained in the meso and macro level effects on high performance energy design.

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