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Grounding Evidence in Design: Framing Next Practices

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Abstract: By focusing on episodes from a case study of healthcare design practice investigated in situ, the aim of this paper is to provide a better understanding of the nature and use of evidence in design. Our account portrays a practice where sources other than scientific research findings were also considered. Based on observations and interviews from the field, the paper first provides a brief account of sources and representations of evidence. The varieties of evidence within the observed practice fall into four major groups: precedents, scientific research, embodied knowledge, and anecdotes. We observed how the participants in the design process used each of these forms of evidence to formulate and explain their design ideas in terms of mechanistic models to form causal links. These mechanistic arguments, which follow a model of scientific thinking, were repositories of trans-disciplinary knowledge involving design and other disciplines.

Keywords: Evidence, Design, Healthcare Architecture

1. Research and Design

The relationship between scientific research and design has often been discussed in the literature (Tetreault & Passini, 2003; Zeisel, 2006;). In the context of architecture for instance, "repeated efforts have been made by the profession both to filter and repackage information in order to make it more easily usable as well as to restructure architectural education in order to make designers more scientifically literate" (Cole & Cooper, 1988: p.110). Even though designers are considered to be the target community to utilize research, there is a significant number of cases reported to demonstrate that designers "do not engage with research findings in a meaningful way and rarely apply then in practice" (Robinson, 2001: p.69). The emerging strategy that designers employ in design decision making is reported to be that of depending on their own experience and expertise (Tetreault & Passini, 2003). This is partly due to the fact that "links to academic and other research organisations and knowledge bases are quite weak and where they do exist, are generally based on individual relationships" (RIBA, 2014, p.6).

On the other hand, the literature demonstrates that there is a growing body of scientific studies providing relevant evidence to support design decision-making processes (see for example Ulrich et al., 2008). There are also emerging institutions or organizations that try to link academic research to professional design practice. Continuous efforts within both research and design fields have led to an increased interest in utilizing relevant research to inform design decisions. Particularly in the field of architecture, evidence-based or research-oriented design practices promote a certain vision where academic caliber investigations providing scientific evidence to guide design work (Verderber, 2010).

Fueled by the progressive efforts mentioned above, the evidence-based approaches are promoted as the frameworks for the practices of the "next". The evidence-oriented framework, following the conceptualization from medicine, offers a new paradigm in practice where intuition together with unsystematic practical experience is devalued, while examination of available scientific evidence is emphasized (Evidence-Based Medicine Working Group, 1992). Although the idea was well-received in some circles within the field of design, what actually constituted evidence in practice is not well-understood, nor is how evidence-oriented practices can be integrated in actual design thinking processes.

Now that more than a decade has passed since the term 'evidence-based design' (EBD hereafter) was coined in the field, our research aims at understanding the nature and use of evidence in design practice, which is becoming increasingly interdisciplinary. Particularly in healthcare design, EBD has a strong rhetoric in favor of reinforcing and utilizing scientific evidence (Ulrich et al., 2008). We conducted situated observations and interviews In a multi-disciplinary practice where participants were aware of the growing interest in evidence-oriented decision-making. Our research seeks to understand the practices around available evidence, in order to provide a better picture of the practices of the next.

There is a variety of research domains to influence design decision making from different vantage points concerning, for example, technology, usability, or sustainability. Within the scope of this paper, we are concerned with research in the field of environment and behavior studies where knowledge about the relationship between human behavior and man-made or natural environments is produced. The paper first provides a brief account of sources and representations of evidence. The next section presents an introduction to evidence-oriented practices with reference to its primary source in medicine. The paper, then, accounts for the types of evidence that were observed, to be introduced by the participants of the case observed. Accordingly, a brief analysis of how different types of evidence were employed and situated within the arguments of the participants is presented.

2. Evidence-oriented Practices

Starting in the early 1990s, the bold assertion of evidence-based practice within the field of medicine gained significant support. It also had been influential in many other disciplines. As Cartwright (2007) suggests, commitment to an evidence-based approach is increasingly being transferred to a range of disciplines such that we can now speak of areas such as evidence-based policy making, education, and design. An evidence-based approach manifests itself in the field of medicine as follows:

> "Evidence-based medicine de-emphasizes intuition, unsystematic clinical experience, and pathophysiologic rationale as sufficient grounds for clinical decision-making, and stresses the examination of evidence from clinical research" (Evidence-Based Medicine Working Group, 1992: p. 2420).

In the field of design, on the other hand, the framework displays a character similar to medicine. According to Hamilton, EBD is "the natural parallel and analog to evidence-based medicine", and "it is the deliberate attempt to base design decisions on the best available research evidence" (Hamilton, 2003: p. 18).

While the framework provided by Hamilton seems straightforward, the healthcare design community –which is inherently interdisciplinary– still struggles to clarify the notion of evidence together with translational processes within design practices (Kennedy, 2010). Following a series of literature reviews that emerge from different domains (Ulrich et al., 2008; Zimring et al., 2013), there is a growing body of evidence to be considered in design processes. However, it seems the developing literature on evidence-based design falls short in providing guidance for practitioners concerned with the strength, applicability, and translation of evidence.

There are, on the other hand, few publications to support the practice of EBD by offering theoretical insights on the utilization of evidence. For instance, Pati (2011) discusses the challenges concerning the credibility and applicability of a given body of evidence in the context of healthcare design. Pati emphasizes "the lack of a commonly agreed-on mechanism to evaluate evidence for use in design decision making" (Pati, 2011, p.70), and suggests an assessment framework that separates the evaluation of strength and quality of evidence from appropriateness in a given context. This particular practice, however, certainly requires designers to develop a new set of skills to elaborate on various aspects of evidence emerging from a variety of sources.

3. The Case

With a critical approach to EBD framework, here we present partial findings of a larger investigation of a healthcare design project to develop a better understanding of evidence-oriented practices. The questions concerning what actually constitutes evidence in design, and how designers utilize evidence in situ shape the core of this paper. The case we present is a replacement hospital project which was initiated by a private health system in the US. The design task was assigned to an interdisciplinary project team comprising architects, interior designers, and a variety of consultants including engineers, physicians, and nurses.

Data collection for this research lasted for a year and involved visits to multiple locations including the offices of designers and other consultants, the hospital where the meetings were held, and the mock-up studio. The field strategies relied on ethnographic observations, semi-structured interviews, and access to project documents including drawings, meeting notes, memos, and online exchanges between participants. We have recorded 33 interviews with participants (all were transcribed and qualitatively coded), 16 design steering committee meetings, and 22 user group meetings.

Within the scope of this paper, however, we only present excerpts from our interviews that were conducted with participants of the study. The open-ended interviews were conducted where the interviewer largely followed the participant's lead. The semi-structured interviews, on the other hand, were guided by themes that the field researcher wanted to address, depending on field observations, and on-going analysis of the data. Semi-structured interviews involve asking descriptive questions without leading participants along a particular line of thinking (Wengraf, 2001). The analysis of the interview data followed a range of qualitative methods including grounded coding, analytic induction, and thematic analysis. The main procedures of grounded coding, namely open-, axial-, and selective-coding, were employed to formulate categories to build concepts from the case observed (Glaser & Strauss, 1967). The varieties of evidence -presented in the next section- represent one of the nine super-ordinate categories that emerged from our qualitative data. Our analytical protocol based on this particular super-ordinate category informed us about the sources and forms of evidence in practice, which eventually helped us to develop an understanding about the participants' reasoning processes around the varieties of evidence.

Based on the data emerging from the fieldwork, we have adopted a broader conceptualization of evidence in order to understand the structure of arguments posed by participants in design situations. Accordingly, in this paper, the term evidence refers to information in various representational forms (i.e. documented or anecdotal) that provide a basis for belief about a phenomenon, which, in turn, affects design decisions. Following the episodes from the field, the next section presents the types of evidence that emerged in the healthcare design practice observed.

4. Varieties of Evidence

Throughout our study, evidence stemming from a variety of sources (i.e., not just science) emerged in discussion and was then re-presented in a variety of forms. This section presents the varieties of emerging evidence. These varieties, however, are not considered mutually exclusive; for instance, a piece of evidence can be considered both as a precedent or embodied evidence.

4.1 Precedents

Precedents, as a form of evidence, were central to the observed practice. Almost every physical environment feature considered in the design process was accompanied by precedents which either had been observed by the participants or was communicated in the form of anecdotes, published case studies, or research conducted in these environments. As participants employed it in their exchanges, the term "precedent" referred to three different entities, each of which represented evidence to challenge design decision making.

First, "precedent" referred to the site visits conducted throughout the early phases of the project during which the participants had observed evidence-in-action. Frequently revisited in later exchanges occurring in meetings, these site visits provided the participants with evidence to suggest whether or not particular design features work in situated healthcare environments. A faulty feature of hand-washing sinks in a hospital visited by the participants, for example, was repeatedly mentioned during design development phases as the team developed the details within the inpatient unit. In an interview, for example, one of the team members put it as follows:

O3 So, uhmm, and then there is lots of evidence about that. Uhmm, I remember going to the site visit, on one of the other hospital. And the hand washing sink was clear across the room, that they decided not to put as soon as you walk in… . But what they did, as soon as you open the door, the light over the hand washing sink came on. And you're naturally drawn to the hand washing sink, because it was lighted. That's what they thought… When I went back to visit that hospital two years later, they turned the lights off, the automatic light over the sink. Because it was disturbing the patients. And on the night time, or two o'clock in the morning, when you walk into a patient's room, the light will automatically come on, over the sink.

Second, the precedents included past experiences in existing facilities to suggest local evidence in decision making. A particular care zone which was developed in the current hospital facility served as a powerful precedent to be considered, modified, and transferred into the future hospital. The use of the word "powerful" indicates the availability of details concerning this particular type of evidence which was still fresh within the hospital's organizational memory as two of the participants had published the case in a healthcare magazine. The case was also supported by developing anecdotes involving the staff members and formal or informal research studies (e.g. satisfaction scores or in-house process improvement efforts) which were eventually translated into design work.

Third, particularly during the visioning phase, the participants were exposed to precedents which were introduced in the form of individual cases that came to bear on issues at hand. The cases introduced in the conferences that participants attended, mostly regarded as best practices, or the precedents emerging from the designers' own repertoire were referred to as sources either supporting or countering claims about individual physical environment features. This type of precedent was not entirely accessible for all participants, but was maintained by individuals who introduced the specifics of such cases as needed.

Either in the form of best practices from industry or local cases, the precedents suggested a set of evidence-in-action to support or refute particular design ideas, which were considered throughout the project. As the design progressed, the set of precedents was collectively assessed, contrasted with (e.g., facilities offering different locations for sinks in patient rooms), and represented in a variety of media (e.g. photographs, drawings), and was eventually crystallized and translated into the architectural drawings as the team approached the deadline for project completion.

4.2 Scientific Research

Although evidence-oriented practices promote scientific evidence as the major support for design decisions as compared to the other varieties of evidence, the use of scientific research providing sound and credible evidence to influence or challenge design decisions has been limited in healthcare(Ulrich et al., 2008). This was also observed in our case. We found that claims about evidence from scientific research circulating in the form of loose statements without any specific reference to a research study. These statements, as they occurred in exchanges within the group, pertained to particular design features at different scales, ranging from handrails in patient rooms to configuration of individual departments.

There were, however, several topics which revolved around individual design features with or without evidential support coming from scientific research. As the participants repeatedly mentioned and discussed these issues in design meetings and interviews, the details around these particular topics had become clear.

During the design of patient rooms for example, the position of the bed within the room, and the location of handrails were observed to be an issue where participants frequently mentioned scientific research to guide design decisions. In an interview, one of the participants had explained the issue with reference to available research:

O4 …uhmm, actually, there's been a lot of research on how you place the head of the bed to the bathroom door. The one thing we found out is there is probably as many things research -wise out there that sort of to some extent will tell you two different locations. But the simple fact to us was there was enough evidence saying you want that to be as close as you can. If you can put a handrail there, that's better.

The excerpt above displays a typical reference to scientific research evidence within exchanges among participants, where the actual sources of that particular research, the context, or the details of the findings were largely missing. Through negotiations, however, the evidence emerging from scientific research was observed to be situated within the new context, namely the developing design of the future hospital.

The debates within the design team around the utilization of a same-handed configuration for patient rooms, also illustrated the nature of scientific evidence considered in healthcare design.

Although the idea was not supported by rigorous research conducted in healthcare environments, the participants decided to pursue and implement this controversial design feature. Despite the source publications on same-handed rooms, which did not provide statistical significance in favor of same-handed rooms, the participants mainly mentioned internal anecdotes as a major reason for the decision that introduced an extra cost for each patient room. This case exemplifies a variety of instances of adopting a particular design feature that makes sense to participants, but is yet to be scientifically proven to be beneficial.

In sum, scientific research, whether providing evidential support or not, offered the themes around evidence to be considered within the interdisciplinary team, rather than providing the definitive direction to pursue. Starting from the pre-design meetings, where the team was exposed to the set of developing scientific research conducted in healthcare environments, participants embraced the issues, rather than the scientific outcomes and reasoning processes that were explicit in research studies.

4.3 Anecdotes

Within frameworks of evidence-oriented practices, anecdote has been characterized as the archenemy. In the practice observed, however, the anecdotes were seen to accompany design decisions at all scales, whether or not there was evidence offered from available scientific research. Our analysis did not quantify the extent to which participants mentioned the different types of evidence. However, the field data allowed us to compare and contrast the patterns on how participants mentioned evidence within their claims. So, for example, our field data allowed us to contrast the use of scientific research, which was mentioned without actual sources, the context, or the applicability of the findings, with the use of anecdotes which were introduced by participants in a vivid and persuasive manner.

The present study demonstrates a role for anecdotal evidence as it is used in practice, which is observed to be critical in maintaining interdisciplinary practice. The anecdotes, whether or not reconcilable with scientific research findings, were employed to *situate evidence* emerging from various sources. Thus, the anecdotes facilitated negotiation between participants with different disciplinary backgrounds. Because they were accessible and easy to propagate, the anecdotes supported and sustained interdisciplinary interaction as the team progressed towards a consensus on design decisions.

The mechanism of situating evidence through the use of anecdotes was employed not only by the healthcare workers who were expected to introduce their everyday practices, but also by the designers who were the ones to take on what they had heard and observed as they interacted with frontline staff. We observed this mechanism to be critical in establishing a mutual sense of the situations involving design features, people, and processes.

The case of developing the design of the fast track area in the emergency department, which was initially designed to accommodate both adult and children, demonstrated how anecdotes facilitate simple and direct decision making in architectural design processes. The configuration of the space was considered following an anecdote introduced by a participant:

O3 …and reason being is because parents do not want their pediatric patients sitting in the same waiting rooms with adult patients. Uhm, you know emergency rooms are for emergencies, and what you can see in adults is patients that are intoxicated, they have... They can be bleeding, they can be throwing up you know... Protection of their child from adult body fluids. Parents just do not want to be sitting there; they want a true pediatric experience.

O3's instant contribution (i.e. parents do not want their pediatric patients sitting in the same waiting rooms with adult patients) was rapidly acknowledged by other participants including the project architects, client representatives, and other staff members in the room. The decision, which involved spatial separation of pediatrics from adult patients, was quickly made and was never revisited as the interdisciplinary team progressed through design development and construction documentation phases. This particular case demonstrates the strength of anecdotes in providing situated cases which helped team members to reach an initial consensus.

Anecdotes, which were introduced in project meetings, were the consistent pieces in larger stories developing around design features considered for the new facility. With little or no variation across participants' accounts, the anecdotes were adopted and re-introduced as needed over the course of the project. Unlike other pieces in particular stories, which exhibited considerable variety in interviews with participants, the anecdotes were largely stable segments which significantly contributed to the understanding and persuasiveness of design ideas.

4.4 Embodied Evidence

Another variety of evidence, different from the available precedents, provided first-hand experience for the participants: *embodied evidence*. This kind of evidence, which was not in place at the outset, was initially generated through a series of mock-up exercises which were strategically created by the architects of the project. Particular design ideas, including the decentralized nursing stations which were not entirely familiar to the nurses from the old facility, were made visible to all participants as they engaged in these exercises and explored the models offered by the mock-up.

By their very nature, the mock-ups utilized in the project allowed participants to modify the initial layout (only for a given set of constraints), further experiment, and tune the configuration to fit their needs. In this sense, the mock-ups enhanced interaction between the design and participating parties, which, in turn, facilitated a process of problem identification and solution development. Embodied experience of the animated care activities involving people, equipment, and processes provided an ecology that was superior to other forms of design representations in deriving and generating evidence on use (Kasali & Nersessian, 2013). As one of the participants put it:

D1 … it just makes you realize that mock-ups are so invaluable that it doesn't matter how much you look at it on paper, you study your sight lines, you know, when you watch all the moving parts, it can change the dynamics of what's going on so heavily. It was very eye opening and very interesting to see that you know, the sight lines, it doesn't take much to compromise.

The mock-ups had a significant effect on the design decisions by enabling local evidence to emerge from a form of in-house experimentation. In sum, mock-ups played a special role in the design because they allowed participants experientially to represent, blend, and generate evidence for designated design issues.

The account presented in this section demonstrates that the evidence made its way to the interdisciplinary design process through different modalities. Unlike formulations within evidence-oriented practices, at least four different varieties of evidence play a significant role in informing design thinking and decision-making processes. Our study leads to the conclusion that the evidence base provided by scientific research has yet to distinguish itself with its primary attributes: rigor, appropriateness, and feasibility. In order to clarify the role and use of scientific research, evidence-oriented practices in design need a deeper discussion of the theory and philosophy of evidence, perhaps initially drawing from the philosophy of medicine literature we noted above. Our case demonstrates that anecdotes, precedents, and embodied practices are likely to remain important sources within interdisciplinary practices for introducing a set of reasons through which practitioners ground their design decisions.

5. Formulating Causal Links

Following the brief account concerning the sources of evidence in practice, now we focus on a particular mode of reasoning where the varieties of evidence are used to support design decisions. Predominantly, the participants employed evidence to formulate particular causal mechanistic arguments in both design meetings and interviews, where they introduced explanations about particular design features. ***Causal argument*** or ***chains of arguments*** are phrases frequently used to refer to constructs that provide a conclusion based on their premises. These phrases also represent qualitative codes –emerging from our interviews with participants- which helped us to develop an understanding of the reasoning processes in practice. In the field, we have recorded a set of the arguments that contained a clear demonstration of a relation between cause and effect, and, occasionally, specific mechanisms with regards to causes (interventions) and effects (outcome). Below is an example of a causal argument taken from an interview with the lead designer on the project;

D1 … They know that day lighting and use of nature improve patient outcomes, reduces length of stays.

The argument above includes two causal statements (provide day light, provide views to nature) which lead to a chain of effects (improved outcomes and reduced length of stays). These constructs became one of the qualitative categories of our analysis.

In project meetings and interviews, mechanistic chain models appeared in participants' statements. An instance from an interview with one of the engineering consultants exemplified this type of mechanistic reasoning as he introduced particular interventions concerning his domain of practice. In the interview segment presented below, the engineer talks about a system, the ultraviolet germicidal irradiation system (UVGI), which has the potential to positively impact infection rates:

M7 Uhmm, use of ultraviolet light in an air handling system to clean the air, there is evidence about what ultraviolet does to keep coolant coil clean, and I've actually been involved in shining ultraviolet on a dirty coil to see what happened, it is remarkable. The sales brochures are actually true. And there is evidence that ultraviolet kills what is in the air… Uhmm, just killing the bugs in the air doesn't mean that you necessarily improve the air quality in the space. You can assume that was gonna get trapped by filtering light. So just measure downstream in filter and tell me the difference. I can't find that out. Let alone actual experiential data for what happens to humans in the space.

The engineer, in this excerpt, introduces a chain of statements bound together to suggest that an intervention (i.e., use of ultraviolet light) could lead to an outcome concerning human occupants. However, the chain is incomplete in that not all steps were supported by evidence, and that the effort to fill in the gaps within the chain was yet unsuccessful (M7: *I can't find that out*). Then, he mentions how one can fill in the missing link by "assuming" benefits that lead to the desired outcome within healthcare environments. Being aware of the missing, un-studied, or less-understood link in this model, the engineer went ahead in a later design meeting to propose utilization of UVGI in the new hospital, and his proposal was well-received by the client representatives.

The architects also introduced chains within a causal argument when asked about the evidence-base related to implementing a particular configuration for emergency services:

D2 Well, the… All we can say is that the reduced the lengths of stay and reduced wait times reduce stress… If you spend time in a waiting room, your stress is increased. Umm, and the process here is that a patient is checked as soon as he or she walks in the door. They are observed by a physician. So that they know exactly where they're gonna go as they walk in the door, rather than, you know, sitting in a waiting room for thirty-five - forty minutes. So, uhm, we can... That's [reduced wait times reduce stress] where the evidence comes from. This is all about reducing wait times, reducing the stress on the patients, and getting them in and out in a more efficient process.

The fast-track area under consideration was projected to eliminate the need for the traditional triage concept and its associated protocols and spaces by introducing a new process using chair-centric bays to reduce waiting times in emergency services. This was suggested as decreasing stress for both patients and hospital staff. Although the idea was initially introduced as a process model, the architects were required to engage in details of care protocols because the protocols would have significant implications for layout configurations. The ultimate aim was to achieve high levels of satisfaction and efficiency by implementing a fast, effective and efficient process in an environment that is inherently full of stress, tension and drama, a characterization partially introduced by hospital staff in the form of anecdotes.

The reasoning processes suggested by participant statements parallel the mechanistic models within evidence-oriented practices in medicine. The Figure below juxtaposes the three chains, one adapted from medical literature (Howick, et al., 2010) and two grounded in our observations, which progress through segments linked by causality.

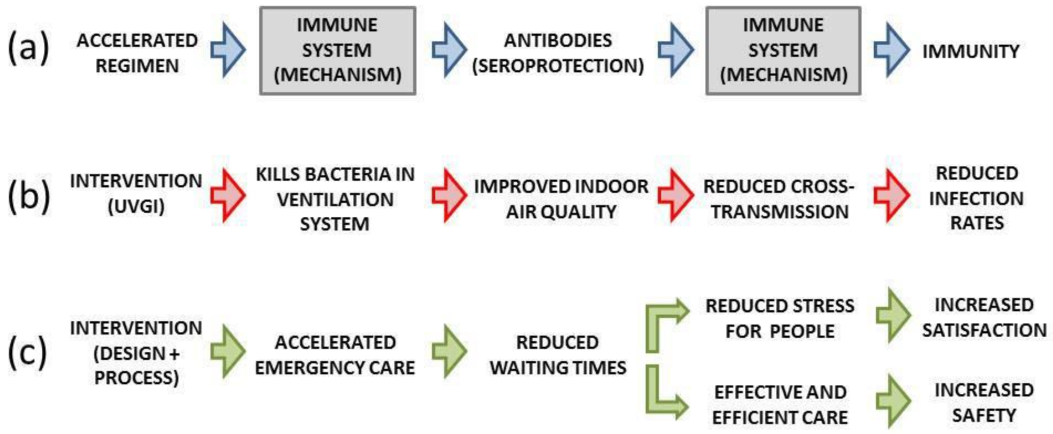

Figure 1.Three examples for causal mechanistic arguments within three domains of practice; (a) medicine, (b) engineering, (c) architecture.

As Howick emphasizes, obviously not all mechanistic reasoning is created equal (Howick, 2011; Howick, et al., 2010), and these models suffer from partially understood or missing links. Accordingly, segments within causal chains in engineering and architecture (Figure b and c) were not fully supported by scientific research so they do not strongly suggest a complete and reliable model of a mechanism. However, the overall structures of the two examples provided in the diagram were created, maintained, and propagated within the larger community of practice and were observed to permeate design thinking as architects or engineers introduced complex interventions (*treatments*) involving knowledge coming from an array of disciplines.

Although other forms of reasoning can be found over the course of the project , causal mechanistic reasoning was observed to be the dominant mode, both individually and collectively, across the members of the interdisciplinary design team. The architects translated propositional forms of these mechanistic models – which included available forms of evidence - into design representations, which allowed other participants to provide feedback, sometimes by means of manipulation to improve the match between causal models and projected spaces of the future facility. This reasoning and translational practice is significant in the way that scientific or causal-mechanistic mode of thinking was recruited by designers, although scientific evidence itself was not playing a major role in interdisciplinary interactions, as presented in our earlier analysis. The way architects thought about the spaces that they were tasked to create and the way they explained these spaces to others contained forms of mechanistic reasoning that incorporated a bricolage of evidence drawn from scientific research, precedents, anecdotes, and in-house experimentation.

6. Conclusions

The brief account presented in this paper demonstrates that evidence in a variety of forms including precedents, scientific research, embodied knowledge, and anecdotes. The participants of the interdisciplinary design team were observed to employ the full range of available evidence, not just that emerging from scientific research, in order to formulate and explain their ideas in terms of mechanistic models to form causal links. These causal mechanisms, by their very nature, accommodated problems that occasionally forced participants to reason beyond their particular disciplines. This is, however, not uncommon to interdisciplinary practices where design practitioners are frequently posed with such complex problems that require complex forms of reasoning. As our case suggests, the complexity not only relates to the necessity to rapidly assess the variety of evidence, but also involves the need to reason through causal mechanistic arguments that are formed by pieces of evidence emerging from different sources. The developing rhetoric of EBD, particularly in healthcare design, proposes a model of practice where design decision making is continuously accompanied by a form of causal mechanistic reasoning in which space is considered as a variable that affects outcomes. How these causal mechanistic models, as conceptual constructs, relate to our understanding of expertise in the practice of architecture poses a critical question to be further investigated.

The mechanistic arguments, which follow a model of scientific thinking, were repositories of trans-disciplinary knowledge spanning several fields including design, medicine, and engineering. Even though the findings of scientific research were not the predominant form of evidence within the observed design decision-making, the rhetoric of implying causal connections was employed, primarily by architects, to persuade the members of the interdisciplinary team. While presenting a cautionary picture of EBD claims about design decision-making, our limited account provides insight into the potential for causal mechanistic reasoning in the next design practices as these evolve into a more transdisciplinary character.

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