Linking Programming, Design and Post Occupancy Evaluation: A Primary Care Clinic Case Study

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ABSTRACT: The architecture design process typically encompasses separated phases or steps leading to a completed building project. Steps may include programming, conceptual design, design development, construction and sometimes post occupancy evaluation. As a result of these distinct steps, it is usually difficult to trace the linear thinking from the beginning of a project to the end of a project. Consequently, the findings produced from each step are not carried forward throughout the process and it is difficult to conduct an assessment of the building in use that is tied to front-end thinking. If these steps are linked in a project, then it would allow for capturing project goals and design attributes (input measures) in relation to desirable outcomes (outcome measures). Various life-cycle process models for architecture were explored in a literature review. While useful, these process models offer limited practical recommendations on how to create a performance-based framework that connects design to measurable outcomes. In response, the objective of this study is to explore an integrated, multi-step process that links programming, research and design with a goal of understanding how design decisions impact building performance. While the use and acceptance of Evidence-Based Design (EBD) research and Post Occupancy Evaluations (POEs) have increased over recent years, most studies don't encompass all steps and are focused on inpatient care facilities. Since outpatient clinics represent the fastest growing segment of healthcare spending and there is limited empirical research on the architectural performance of these healthcare settings (Preiser, Verderber, & Battisto, 2009), a primary care clinic was chosen to explore this integrated process.

KEYWORDS: life-cycle model, performance-based framework, post-occupancy evaluation, primary care

INTRODUCTION

According to a 2011 National Center of Health Statistics (NCHS) report, there were 1.2 billion ambulatory care visits in the United States in 2007, with 48.1 percent of these visits being to primary care physicians in office-based practices (Schappert & Rechtsteiner, 2011). The rising demand for primary care services is influenced by demographic changes, including an aging population expected to increase from 12.7 percent of the total U.S. population in 2008 to over 20 percent of the total U.S. population by 2050 and a rise of chronic conditions prevalent in this population (Mann, Schuetz, & Johnston, 2010). The crisis primary care confronts "is a result of the confluence of a rising demand for primary care services and a decreasing supply of professionals providing these services" (Mann, Schuetz, & Johnston, 2010, p. 9). This crisis is further heightened by a lack of standardized facilities, technologies, and equipment across practices that would improve coordination and collaboration. While these challenges are clear, the availability of planning and design guidance tools are limited for this healthcare setting type.

Feeling the pressures of improving their primary care clinics, a local health system wanted to explore a new prototypical design for their family practice clinics and reached out to a nearby university that specialized in healthcare architecture. After discussions, it was decided that the development of a new prototype was an ideal project to work toward linking pre-design activities (such as programming and conceptual design), with design development and construction and finally to a post-occupancy facility assessment.

Literature Review

A literature review was conducted focusing on two relevant areas: lifecycle process models in architecture, and post-occupancy evaluation. Below are the findings from the review. First, an overview of three theoretical process models for architecture is presented - they recognize the facility lifespan from the pre-design phase to the post-occupancy evaluation phase. Second, Post Occupancy Evaluation is reviewed proving insight on how a building in use may be assessed according to the upfront planning decisions, design attributes and measurable outcomes.

Life-cycle Process Models: From Pre-Design to Building Occupancy:
Three theoretical process models for architecture that recognize the facility's lifespan from pre-design to post occupancy considered for this study include: the *Design Development Spiral Model* by John Zeisel (1981), *Building Performance Evaluation (BPE) Process Model* (Preiser & Vischer, 2005), and the *Center for Health Design's (CHD) Evidence-Based Design Process Model* (Center for Health Design, n.d.). First, in his book, *Inquiry by Design: Tools for Environment-Behavior Research*, John Zeisel (1981) sets out basic concepts regarding the relationship of research and design. He claims that the researcher learns by making hypothetical predictions, testing ideas, evaluating outcomes, and modifying hypotheses. This spiral model includes: design programming (research particular object's design); design review (using the knowledge from existing environmental behavior research to assess a design's conformance); and post-occupancy evaluation (a comparison of the actual completed in-use project with the original goals and hypotheses of a design) (Hourihan, 2011). Second, The BPE Process Model is a life cycle model based on expanding the post-occupancy evaluation model developed by Preiser, Rabinowitz, and White (1988). The phases included in the BPE model are programming, planning, design, construction, occupancy, and recycling. This cyclical model spans from pre-design to post occupancy, with each building cycle looping forward to and informing the next project cycle. Finally, the Center for Health Design's Evidence-Based Design (EBD) Process Model includes five phases: organizational readiness, pre-design, design, construction, and occupancy. The steps that inform each phase of the project include: definition of EBD goals and objectives, finding sources of relevant evidence, critical interpretation of relevant evidence, creating and innovating EBD concepts, developing a hypothesis, collecting baseline performance measures, monitoring implementation and design construction, and measuring post-occupancy evaluation results (Center for Health Design, n.d.).

While these theoretical models have individual strengths, they offer limited recommendations towards practical solutions that link programming, design and research activities throughout the architectural process. Additionally, they offer limited practical recommendations to translate findings into planning and design recommendations for future projects. There are some resources available to guide decision making for outpatient care but they focus on minimum room-type areas and technical requirements. Following is a summary of the resources considered for this study (Table 1). Overall, these resources, lack information that is critical for effective planning and design of outpatient clinics.

Table 1: Healthcare facilities guidance tools analysis

Sources	Information Provided in Tools	Limitations
FGI Guidelines for the Design and Construction of Healthcare Facilities (2010)	Provides minimum recommendations for: ▪ Room area sizes ▪ Lighting, Acoustics, Mechanical and Electrical requirements	Limited to minimum values No recommendation of the overall clinical modules and room layouts
Whole Building Design Guide (WBDG)	Provides general recommendations including the implementation of: ▪ Modular concepts ▪ Room area standards ▪ Adjacencies ▪ Design features to reduce environmental stressors	Limited to general recommendations No recommendations of room area sizes and layout, and the overall clinical modules
SpaceMed (Hayward, 2006)	Provides specific information regarding: ▪ Space program requirements ▪ Area calculation methods ▪ Room area sizes	No recommendations of the overall clinical modules and room layouts
Department of Defense (DoD) Space Planning Criteria and Templates	Provides specific information regarding: ▪ Space program requirements ▪ Area calculation methods ▪ Room area sizes ▪ Room layouts ▪ Technical requirements	Limited to room requirements excluding the overall clinical modules

Post-Occupancy Evaluation:
"Post-occupancy evaluation is the process of systematically comparing actual building performance, i.e., performance measures, with explicitly stated performance criteria" (Preiser, 1995). The concept of Post-Occupancy Evaluation (POE) was introduced in the 1960s and has evolved into a discrete process of building performance review (Mallory-Hill, Preiser, & Watson, 2012). In 1988, Preiser, Rabinowitz and White published the first book on Post-Occupancy Evaluation, entitled *Post Occupancy Evaluation*, which became the primary reference for POE. Initially as an assessment tool, POE aimed at receiving user feedback to ascertain how well the designed settings satisfy and support human needs and values of the building occupants. POE includes "any and all activities that originate out of an interest in learning how a building performs once it is built, including if and how well it has met expectations." (Preiser, Rabinowitz, & White, 1988; Preiser & Vischer, 2005; Vischer, 2001, p.23). Following are the various levels of POE that have been introduced by Preiser, Rabinowitz, & White (1988) ranging from a very high level review to a detailed, in-depth study (Table 2).

Table 2: Post-occupancy evaluation levels of effort

Post-Occupancy Evaluation Levels of Effort	Purpose	Methods
Indicative	Provides an indication of major strengths and challenges of a building's performance	Archival and document evaluation Walk-through evaluation Interviews
Investigative	Provides a thorough understanding of the causes and effects associated with behavioral, functional and technical building performance using explicitly stated evaluation criteria	Literature assessment Walk-through Survey Interviews Focus group
Diagnostic	Provides a correlation of physical, environmental and behavioral performance measures with subjective occupant response measures	Walk-through Survey Interviews Focus group Technical readings Observation

POEs for general building types have targeted different performance measures classified in three areas: functional, behavioral, and technical (Preiser, 2003). Applied to the context of healthcare and to the particulars of primary care clinics, four outcome categories of performance measures were identified for this project including positive experience (similar to behavioral), operational efficiency (similar to functionality), clinical effectiveness (new), and healthy environment and sustainability (similar to technical). Based on the literature reviewed, a combination of these four different performance areas may provide the most balanced assessment. As a result, a performance-based framework that incorporates the initial design goals and the critical issues that influence primary care facilities was developed to inform the post-occupancy evaluation effort of this pilot study.

Methodology:
Project Team, Scope, and Timeline:
A partnership was formed between Clemson University's School of Architecture, NXT Health, and a health system. A multidisciplinary approach to plan, program and evaluate a prototypical design for a family practice clinic was initiated. The intent was to expand upon the traditional view of health and redefine patient expectations by providing efficient, high quality care that leverages the latest technologies within the context of healthy and sustainable spaces.

The programming and conceptual design phase was completed in the spring of 2009 as a service learning project with Clemson University's Architecture + Health programming and pre-design seminar. Based on a series of collaborative work session, planning goals and objectives were established as well as the space needs and other operational requirements. Following the programming phase, a final conceptual design was developed during the summer of 2009 with faculty and students. Once the schematic design was completed, an architectural design firm was selected to further develop the conceptual design and prepare the contract documents. The facility was built in 2010 and the planning for a Post Occupancy Evaluation began by a different team at Clemson. A POE study protocol for Institutional Review Board approval was submitted in January 2012 and received in February 2012. A team from Clemson University conducted a post-occupancy evaluation in the summer of 2012. Lessons learned from the post-occupancy evaluation are currently being translated into design guidelines for the next family practice clinic project.

Overview of steps:

Three critical steps have been delineated in the project's multi-step process: 1) Programming and Conceptual Design, 2) Professional Design and Construction, and 3) Post-occupancy Evaluation. Table 3 summarizes the steps including the purpose, the groups involved, and the goals and deliverables, followed by a brief discussion of each step.

Table 3: Overview of steps

Architectural Process Steps	Groups Involved	Goal	Deliverables
1. Programming and Conceptual Design *Purpose: Develop the project scope, guidance criteria and conceptual design*	Clemson University and NXT Health in collaboration with the Health System	*Guiding:* ▪ Develop project scope ▪ Translate findings from interactive work sessions ▪ Use research to identify planning and design recommendations ▪ Develop conceptual design that captures project goals	*Guidance Criteria:* ▪ Project mission and vision ▪ Project goals and objectives ▪ Spatial, functional and operational needs *Conceptual Design:* ▪ Facility and key rooms ▪ Design strategies and concepts ▪ Conceptual design
2. Professional Design *Purpose: Develop the professional design informed by the guidance criteria and conceptual design*	McMillan Pazdan Smith Architects with Clemson University as a consultant	*Implementing:* ▪ Translate guidance criteria and conceptual design to achieve project goals and objectives	*Professional Design:* ▪ Existing building retrofit to move conceptual design forward into design development and produce a set of construction documents
3. Post-occupancy Evaluation *Purpose: Assess the quality of the physical environment*	Clemson University in collaboration with the Health System	*Measuring:* ▪ Learn how the built environment achieves the client's established goals and objectives by connecting design attributes and measurable outcomes	*Final POE Report:* ▪ Analysis of the facility in-use to identify strengths of the facility design and areas of improvement.

Step 1: Programming and Conceptual Design Development:

The process and outcomes for this step are described in detail in Battisto, Thomas, Whitman, & Weeks (2009). Simply put, this research included a literature review, case study and observation research in three family practice clinics, and four collaborative work sessions with client stakeholders. During this phase, the project team developed qualitative guidance criteria including the project mission, vision, goals and objectives. Additionally, quantitative data was produced including the functional program, a space list and key room area sizes. These data were translated into design strategies and concepts informing a conceptual design for three different scenarios including a two, three and four physician clinical pod module.

Figure 1: Conceptual design developed by Clemson University

Step 2: Professional Design and Construction:
In order to develop the facility professional design, collaborative work sessions were conducted with the selected architectural design firm to advance the conceptual design proposal developed in the programming phase into the final schematic design and construction drawings. The implementation of the planning criteria resulted from a dialogue with all team members allowing a seamless and direct transfer of the concepts into the final design. It is also important to note, that the professional architecture firm was involved in some of the initial programming and planning work sessions. In the end, the selected project site was to be a retrofit of an existing new facility therefore the proposed design was finally developed for a two- physician clinic.

a. Waiting Concourse b. Reception Area c. Assessment Room

Figure 2: McMillan Pazdan Smith Architecture professional design, Photography by Kris Decker/Firewater Photography

Step 3: Post-Occupancy Evaluation:
The health system had an overarching goal to improve operational efficiency in their family practice offices. Given the assets of the team (expertise in clinical operations, architecture, research), it was envisioned that this initial prototype could be used to study if and how the facility design impacted the client's two top goals: to operational efficiency and the patient experience. In pursuit of this goal, the POE developed for this project incorporates features of the indicative and investigative approaches noted by Preiser (1988), and provided a focused assessment of a single family practice office. This research project was an exploratory study to assess the efficacy of the built environment. A case study research design process was employed, utilizing mixed methods inclusive of both quantitative and qualitative approaches. The post-occupancy evaluation was organized in two main phases: 1) Facility Documentation, and 2) Facility Performance Evaluation. Informed by the literature in healthcare design and research, a performance-based framework was developed to link design attributes to measurable outcomes. Below is an example of one outcome category within the overall performance framework (Figure 3). A more expanded framework was developed to include four outcome categories: Positive Experience, Operational Efficiency, Clinical Effectiveness, and Healthy Environments and Sustainability.

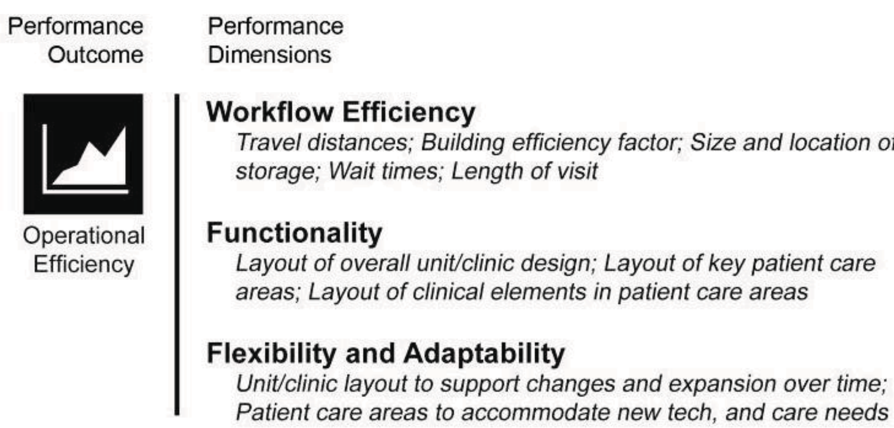

Figure 3: Performance dimensions and key metrics to assess operational efficiency

To conclude the authors have summarized the research activities conducted during each step of the multi-step process.

Table 4: Architectural process model

Architectural Process Steps	Activity	Methods
"Guiding" 1. Programming, and Conceptual Design	Identify the critical issues that influence primary care clinics	Literature Review
	Study "best design practices" in primary care clinics	Case Study Research
	Identify key issues linked to outcomes in three primary care clinics	Observation Research
	Define spatial, functional and operational needs. Finalize project goals, objectives, design strategies and concepts	Collaborative Work Sessions
"Implementing" 2. Professional Design and Construction	Collaborative work sessions to refine the space list, and the space and operational planning criteria	Professional Design Services and Construction
	Refine and apply design concepts and strategies into a schematic design	
	Develop professional design, construction drawings and specifications	
	Execute project bidding and negotiation	
	Complete project construction	
"Measuring" 3. Post-occupancy Evaluation	Seek approvals and request facility data and planning documents	Archival Research
	Capture the physical environment using measured drawings	Floor plan take-off
	Generate diagrams to capture the design concepts across the performance dimensions	Facility Diagramming
	Verify on-site facility information and answer questions from take-off analysis	Facility Verification
	Document facility environmental features using a visual format	Photographic Profile
	Review the design intent of the facility	Architect Fact-Finding Interview
	Familiarize the POE team with the overall facility	Guided Facility Walkthrough
	Understand patients, family and staff perceptions of the facility design with respect to the performance dimensions	Survey
	Gain insight on how the facility performs in practice with respect to lighting, temperature and acoustics	Technical Readings
	Gain insight on the care delivery process by documenting patient and staff steps and flow patterns	Observation Research

Findings:

Integration of the Three Steps:

The purpose of the multi-step approach is to establish a relationship between decisions surrounding physical environment (identified during the programming phase and design phase) and the desired outcomes (studied in the POE). Understanding associations between the physical environment and outcomes can yield insight that may be used to inform our future design decisions. In this pilot study, three critical steps were connected: 1) Programming and Conceptual Design, 2) Professional Design and Construction, and 3) Post-Occupancy Evaluation. To connect these three steps, a table was developed to outline the linear thinking using the performance framework as a structure. The table linked project goals and design concepts with the outcomes areas, and was later used to assess the facility performance during the post-occupancy evaluation. Table 5 shows one example of how goals are aligned to performance outcomes, dimensions and design concepts including objective and subjective metrics to assess workflow efficiency.

Table 5: Linking design to outcomes for workflow efficiency

Project Goals	Performance Outcome	Performance Dimension	Key Design Concepts	Metrics *Objective*	Metrics *Subjective*
The design of the facility should assure a high quality of care through the adoption of efficient work processes	Operational Efficiency	Workflow Efficiency	1. Clear organization of office, clinical, and provider zone 2. Separate patient and staff circulation flow patterns 3. Direct access to patient care areas for patients and family 4. Direct access from staff work areas to patient care areas	▪ Area calculations ▪ Travel distances ▪ Time	Staff satisfaction with workflow efficiency

Following is an example of the conducted POE analysis for workflow efficiency (Figure 4).

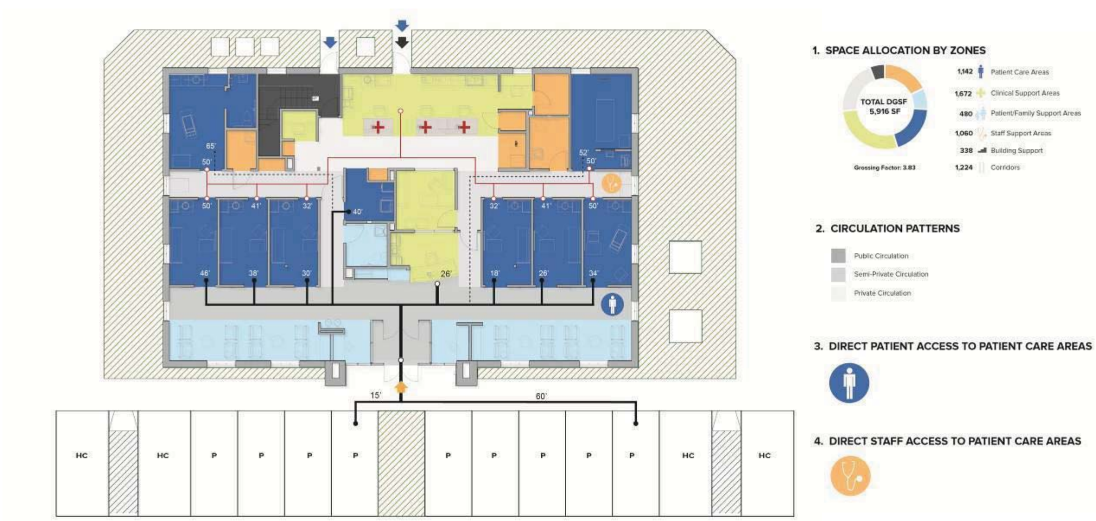

Figure 4: Post-occupancy evaluation analysis for workflow efficiency: clinical modules, circulation hierarchies and patient and staff travel distance

Based on lessons learned from conducting this project, the authors defined three steps: 1 *Guiding* the project scope, goals and conceptual design; 2 *Implementing* the ideas into practical design solutions and 3. *Measuring* if and how the design concepts are linked to desirable outcomes. These three steps should be linked throughout the architectural process and have been delineated in Table 4. The authors argue that the proposed multi-step model should be anchored by a performance-based framework determined during the programming and conceptual design phase of the project. The performance-based framework can be used for "guiding" the decision-making process throughout the project cycle. Clearly established "guiding" criteria developed at the programming and conceptual design phase of the project allows for "implementing" seamlessly the design concepts and design strategies leading to the final project design. The post-occupancy evaluation focused on "measuring" how the facility performs when studied after the building is in use. In summary, this multi-step process model encourages an integrated and transparent approach to programming, design, and evaluation anchored by identified performance outcomes and dimensions.

CONCLUSION

The development of a multi-step process anchored by a unified framework advanced knowledge by linking research and design. The results of the post-occupancy evaluation demonstrated the value of conducting research in a systematic and rigorous manner during the programming phase of the project. The development of a framework to document the project goals and the associated design concepts and performance metrics allowed the researchers to establish a relationship between the key environmental factors and performance outcomes that lead to excellence in design with the purpose of improving building performance. As a result, the development of a performance-based framework to guide the architectural process advances knowledge by exploring pathways to inform the architects' design decision-making process. Additionally, it assists the facility documentation process conducted as the initial phase of a post-occupancy evaluation by accurately documenting the hypothesized project goals and the key performance indicators considered in the programming and design process.

To summarize, the main contribution of this study is the development of a multi-step process that linked systematically research and design leading to an informed design decision-making process. Additionally, this study explored the initial development of a performance-based framework to guide the architectural process. The implementation of the multi-step process anchored in a unified framework allowed for an integrated and seamless translation of the project goals and objectives throughout the architectural process. This unified framework becomes relevant when the project steps are conducted by multiple companies. Additionally, it will inform the architects from the initial programming phase the evaluation criteria that will be employed during the post-occupancy evaluation to assess compliance with the hypothesized project goals. However, to explore the full potential of post-occupancy evaluations, which includes the translation of lessons learned into useful guidance tools to inform design decisions, future studies should focus on further developing a performance-based framework informed by the critical issues that influence primary care facilities. The development of such a framework will allow replication of the proposed multi-step process across multiple primary care facilities leading to the development of a data repository and guidance tools that can help inform future primary care design decisions.

ACKNOWLEDGEMENTS

The authors would like to thank Justin Miller for graphical support; Sonya Albury-Crandall and Mason Couvillion for advancing the our thinking on a life cycle model, Wolfgang Preiser for his mentorship and the Department of Defense for providing us the opportunity to conduct POEs for the Military Health System.

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