Design Logics: A Diagrammatic Approach to Research and Representation of Health Pathways in the Built Environment

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Frameworks to conceptualize and evaluate programs in public health can be adapted as tools to guide research and contribute to the visual culture of architecture. One such framework is a logic model, a graphic tool that details specific components of an intervention and the proposed short and long-term outcomes. The logic model is a cornerstone of program planning and evaluation, a systematic method for collecting, analyzing, and using data to examine the effectiveness of a specific program and to understand why it may or may not be working as planned. The tool has been used to assess the health outcomes of plans, policies, and projects in urban planning through a methodology called Health Impact Assessment (HIA). The collaborative research process to develop a logic model has the potential to play a more generative role in architectural design. In this paper, I explore methods to bring the logic modeling process into design pedagogy and to promote potential applications in integrative design practices. Three examples are examined: 1) a logic model used in a comprehensive HIA of a community development project, 2) visualization of scientific research, and 3) a logic model representing a solution for an intergenerational health center in a design competition. Logic models can play a significant role in the design, evaluation, and monitoring of health outcomes in architectural projects at any scale and level of complexity. The work will demonstrate the potential of using logic models to conceptualize projects from the earliest stage of development to support integrative and collaborative research methods in design.

INTRODUCTION

> "If you build it, he will come."
> – Field of Dreams[1]

The design of environments that contribute to human health and wellbeing and simultaneously address critical problems like global climate change demands new ways of practicing and educating future architects and designers to think, communicate, and collaborate across disciplines. Research plays a critical role in the development of solutions that meet specific performance metrics and operate at the diverse scales of ecological systems, cities, landscapes, buildings and interior environments. The challenge of bringing scientific research knowledge into practice and education requires bridging an old divide between a traditional practice of architecture that relies on formal education, standards of practice, and general professional knowledge, and one that seeks to integrate a growing base of peer-reviewed research from diverse and related fields of study.[2] The medical community has addressed the divide between research and practice by focusing on the evidence-based practice of medicine. The National Institutes of Health (NIH) promotes the training of basic and clinical scientists in translational research programs and facilitates the flow of information from "bench to bedside". Although the architecture profession does not have an institution analogous to the NIH for the built environment, the subfield of healthcare architecture has adapted the evidence-based practice of medicine to Evidence-Based Design, which seeks to apply the best available scientific evidence to healthcare design. The study, "View through a window may influence surgery recovery" by Roger Ulrich, has been a catalyst for the Evidence-Based Design movement in architecture. The study found that patients with views of trees had better health outcomes including faster recovery time and reduced pain medication than the patients who experienced views of a brick wall of the hospital. The Ulrich study is considered to be a seminal work linking the environment to health and has been cited over 1500 times.[3] Another way Evidence-Based Design has been applied to the built environment is through the application of Health Impact Assessment or HIA, which seeks to apply the best available evidence to inform decision-making in projects like neighborhood zoning, transit-oriented development, and affordable housing.

HEALTH IMPACT ASSESSMENT (HIA)

HIA is a tool with broad applications and is practiced in Australia, New Zealand, Europe and the U.S. and promoted by the Centers for Disease Control (CDC), Robert Wood Johnson Foundation, and the Pew Charitable Trusts.[4] HIA is typically a voluntary process applied by local and state level stakeholders to fill a gap in the regulatory framework of Environmental Impact Assessment, which does not consider the full range human health issues including social determinants of health. The National Research Council has adopted the following definition of HIA.

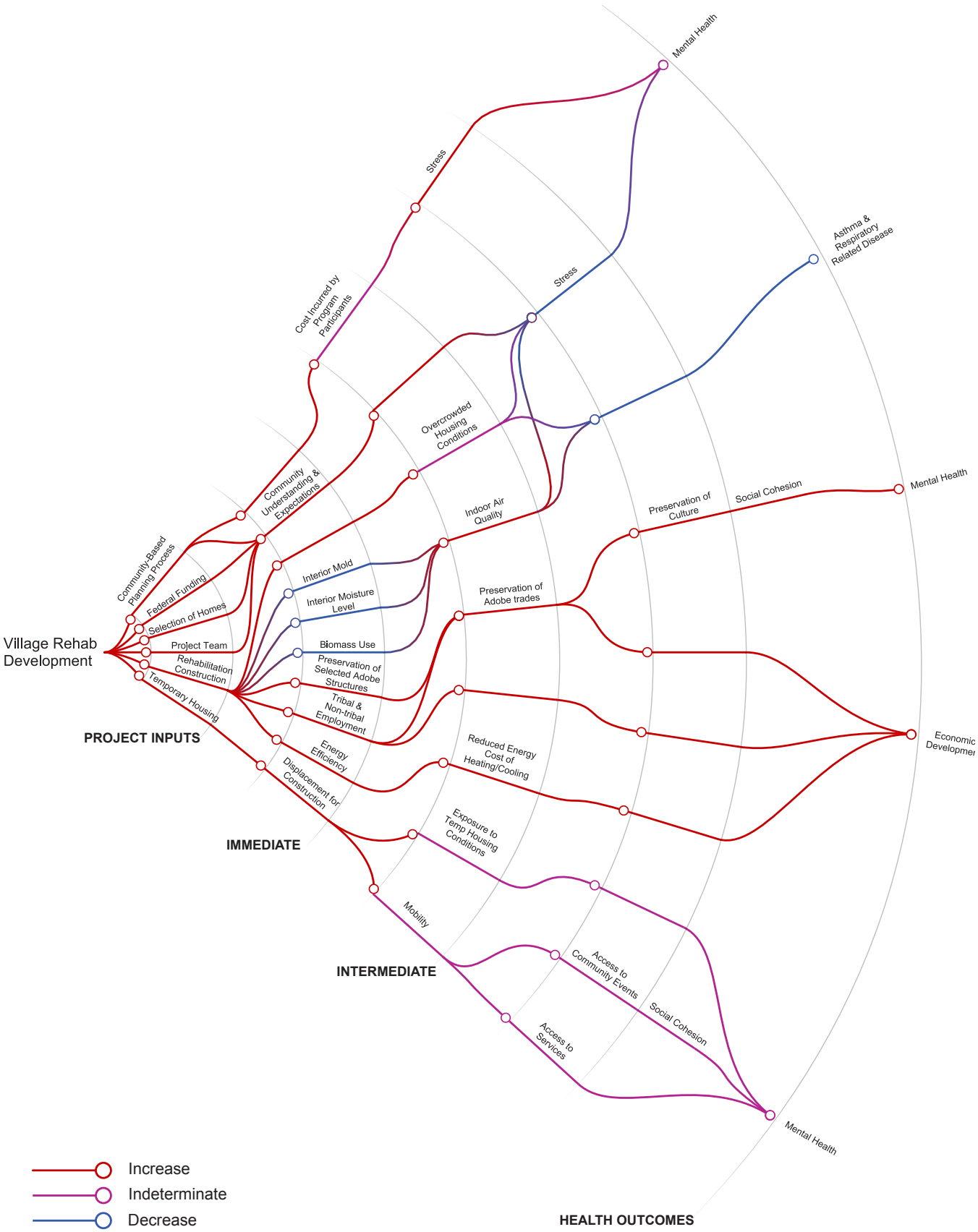

Figure 1: Health Impact of Rehabilitating Native American Adobe Housing. Schaeffer Somers and Xuting Jin (UVA MArch ’20).

HIA a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of the effects within the population. HIA provides recommendations on monitoring and managing those effects.[5]

HIAs can be used to build a consensus among stakeholders for recommendations to mitigate negative health impacts and enhance positive health outcomes. The types of HIA range from a Desktop HIA, which focuses on existing research and requires the least amount of resources including time, to a Comprehensive HIA, which requires a high level of community engagement and a high level of resources and effort. The HIA for rehabilitating Native American housing referenced in Example 1 is a comprehensive HIA. The practice standards for HIA require that the scoping phase of the project include "a systematic consideration of potential pathways that could reasonably link the decision and/or proposed activity to health, whether direct, indirect, or cumulative".[6]

The conventional way to systematically analyze these "health pathways" is through an adaptation of the Logic Model, which comes out of the field of program planning and evaluation. A logic model takes the form of a tree diagram that begins with an input and depicts how the inputs lead to measurable outcomes. It provides a visual representation of the "theory of change" of how a particular input will manifest itself over time in the form of immediate, intermediate, and long-term outcomes.[7] The input can be anything delineated as a discrete and bounded set of components such as a building or master plan. Each input leads to at least one output through a causal connection. Outputs become new inputs as the diagram traces causal pathways outward in the direction of the change in time. Following the conventions of evaluation, the logic model should identify metrics that can be used to monitor the performance of the program after implementation of the recommendations. In the practice of HIA, the diagram is organized into immediate, intermediate and distal "health outcomes", which are the likely and expected changes in the health of the impacted population. In HIA practice, the logic model is referred to as a Health Pathway Diagram since the connections represents causal pathways to future health outcomes. The tool is used primarily to determine the scope of the HIA project, however, I require my students in HIA courses to represent the predicted state after the HIA recommendations are implemented in a "before and after" approach to the analysis. In this scenario, logic modeling becomes an iterative process of secondary research.

SYNTHESIZING LOGIC MODELS

The development of a logic model requires an understanding of specific causal connections between inputs and outputs, which begins with the intrinsic knowledge of the researcher and designer. The process is similar to mind mapping and will reveal gaps in knowledge and relationships that require a literature review to resolve. To do this effectively, students need to be able to frame research questions, conduct literature searches, assess the relevance of evidence, and document findings in a literature review table. The primary source of scholarly literature in biomedical research is PubMed, which is a public resource developed and maintained by the National Center for Biotechnology Information (NCBI), at the U.S. National Library of Medicine (NLM), located at the National Institutes of Health (NIH). Literature is tagged with MeSH (Medical Subject Headings) terms. Literature in PubMed is organized in a controlled vocabulary of MeSH terms, which designers can use to develop a conceptual understanding of biomedical knowledge. Web of Science is another website that provides access to multiple databases of citation data related to multiple disciplines including social sciences and psychology, which are critical to understanding social and cognitive impacts. Students are required to document their search strategies so they are repeatable and can be iterated to improve search results. This type of literature review is best described as an integrative literature review, which is used in "evaluating the strength of the scientific evidence, identifying gaps in current research, identifying the need for future research, bridging between related areas of work, identifying central issues in an area, generating a research question, identifying a theoretical or conceptual framework, and exploring which research methods have been used successfully."[8] Since research studies are typically based on a narrowly defined population, a key skill is assessing whether the findings can be applied to another population. Assessing the generalizability of literature requires the researcher to make a rational argument based on the best evidence available. The three examples that follow illustrate how this process has been applied and adapted to a range of assignments and projects in an academic setting.

EXAMPLE 1: A LOGIC MODEL FOR A COMMUNITY DEVELOPMENT HIA

I was the Principal Investigator for a comprehensive HIA that was funded by the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and the Pew Charitable Trusts. The Health Impact Project promotes HIA practice with local, state, and national organizations to include health considerations in policy decisions across multiple sectors of policy and program development.[9] The HIA assessed the community development work of an Enterprise Rose Fellow[10] working with a Native American Tribe in New Mexico as part of a three-year fellowship. The HIA examined four project domains; new single-family housing, rental housing, a landscape design connecting community centers with walking infrastructure, and the rehabilitation of adobe dwellings. The research to understand the existing conditions of community health began with student projects in a HIA course taught in the Department of Public Health Sciences in the School of Medicine with participation of undergraduate and graduate level students from Architecture and Urban Planning. The student work was edited to meet the Minimum Elements and Practice Standards [6] required by the

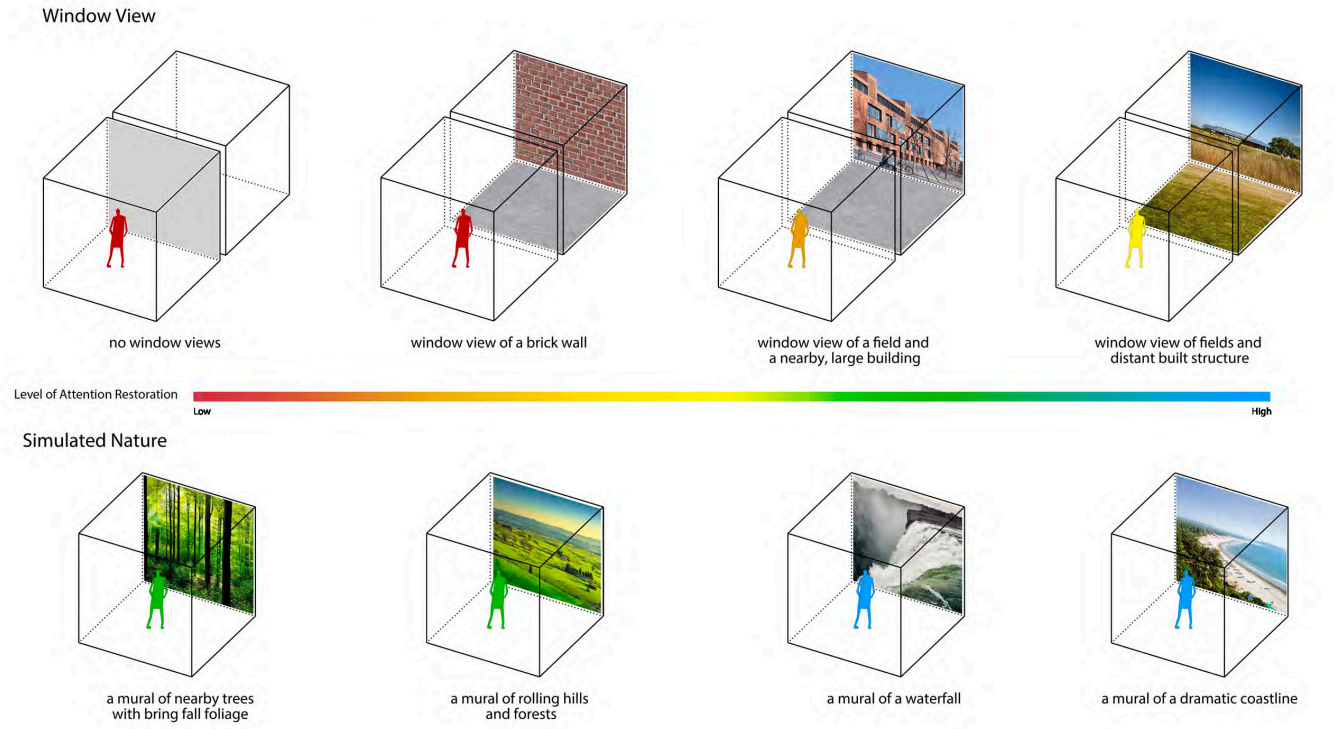

Figure 2. Diagrams of study environments and affective response, Xuting Jin (UVA MArch '20)

Health Impact Project. A separate health pathway diagram was produced for each of the project domains. Each health pathway diagram traces the potential health impacts and outcomes identified by the stakeholders and found in the literature review of the HIA. The process begins with unpacking the program into its component parts as the inputs to the logic model. The complexity and density of the aggregated relationships can create a graphic design problem. The diagram can be organized into a series of subgroups to improve readability. Cluster dendograms[11] and other forms of information visualization also offer new ways to represent the relationships in logic models as shown in Figure 1.

In the case of the HIA of adobe rehabilitation work, the health pathways are primarily concentrated around the input of the construction work and include relationships that result from the community-based planning process and the relocation of residents during construction. To illustrate, one pathway in the rehabilitation work flows from the input of preserving adobe structures, which preserves adobe construction knowledge and supports the preservation of traditions in the pueblo culture as intermediate impacts. The preservation of culture contributes to an increase in social cohesion and would contribute to improved mental health. The diagram demonstrates that many outcomes are indeterminate with potentially negative health outcomes resulting from the displacement of residents during construction to temporary housing located outside the village center. This health pathway results in a decrease in mobility and access to community events, which will have a negative impact on mental health and social cohesion of the tribe. Another impact that was revealed in this process is that there was not sufficient information and training provided for new heating systems that replaced biomass stoves. And while the restoration of adobe was viewed as a benefit to the Tribe by the Rose Fellow and the HIA team, the assessment revealed that the perceived value of the adobe with traditional plasters was not universally valued by the Pueblo community. The assumption of mental health gains from adobe rehabilitation based on perceived cultural value would require additional research to confirm the link for this particular community.

The logic model is not intended to be a one-time exercise or a complete representation of all of the potential factors and measurable outcomes for population level health. It is one instance of a theoretical framework that should be iterated as new information becomes available from the literature review as well as qualitative findings from community engagement. The idea of a logic model as a "theory of change" is appropriate since it is informed by the best available knowledge and represents a framework for testing hypotheses and monitoring health outcomes. Applied to the built environment, the logic model can provide structure for post occupancy evaluation and informing future decision-making.

EXAMPLE 2: LOGIC MODEL AND VISUALIZATION OF

DESIGN RESEARCH

Architecture is a visual culture and it is important to identify methods of representation to communicate and translate knowledge that can be immediately assimilated into design concepts. Logic models can complement visualization and representation of principles in scientific literature. I used this approach in an Architecture seminar that reviewed scientific research in Environmental Psychology and Neuroscience to identify principles and methods of designing environments to promote health through multisensory and cognitive pathways. A key learning objective was the visualization of research to identify interactions, relationships and parameters that can be applied to design workflows. Figure 2 is the work of a student visualizing the research findings of an article titled "Where to take a study break on the college campus: an attention restoration perspective."[12] The study compared exposures through window views and simulated nature to understand the response of a student population. The logic model in Figure 3 traces the responses of subjects in a separate study[13] exposed to photographic images of clouds in a healthcare setting. It demonstrates the potential of diagramming research at the scale of the individual physiological and cognitive response. The combination of the two diagrams represent a set of ideas that could potentially inform an architectural design concept.

EXAMPLE 3: A LOGIC MODEL OF A BUILDING DESIGN

This example demonstrates the potential of developing logic models at the beginning of the design process. This approach was applied to a student design charrette sponsored by the AIA Academy of Architecture for Health, which promotes evidence-based design of healthcare facilities. The project team designed an intergenerational center for wellness that included program for youth and senior citizens. Downtown Orlando has a growing senior population and the center would serve as a daily community center for seniors offering mental and physical health amenities such as food services, gym, library, and pharmacy, along with clinical services. Figure 4 is the logic model used to identify the health impacts and co-benefits of intergenerational programming for the senior and youth populations.

The key finding for the senior users is that the program would reduce social isolation and loneliness that would improve the mental health and reduce risk of disability from falls. Other health outcomes include reduction in obesity and hypertension for the population served. The youth who use the center and interact with the elder population would benefit from knowledge sharing, critical thinking, non-cognitive emotional skills, which would increase their empathy, respect for elders, and educational outcomes. The evidence base for causal relationships to Alzheimer's disease and cancer is less well established, but the diagram can be used to graphically communicate the strength of evidence. The rendered spaces reflect the findings of Ulrich's study and research in Attention Restoration Theory by introducing green space in courtyards as a way to reduce stress in waiting rooms for the senior health clinics. (Figure 5).

The work demonstrates the potential of developing logic models in advance of or in parallel to the formal design process. Undertaken as a collaborative process, the logic model becomes a shared mental map of the design potential and how the system of the proposal would change the health of the population of users who would interact with the architecture. HIA is ideally undertaken as a collaborative, community-based process with stakeholders, so modeling the health impact of potential designs could be undertaken as a collaborative process with clients and communities. By looking further downstream, the logic model process can build the case for investment into program elements that are linked to health outcomes, which can have measurable economic benefits to the client if researched and documented. At a minimum, the process can reveal unintended

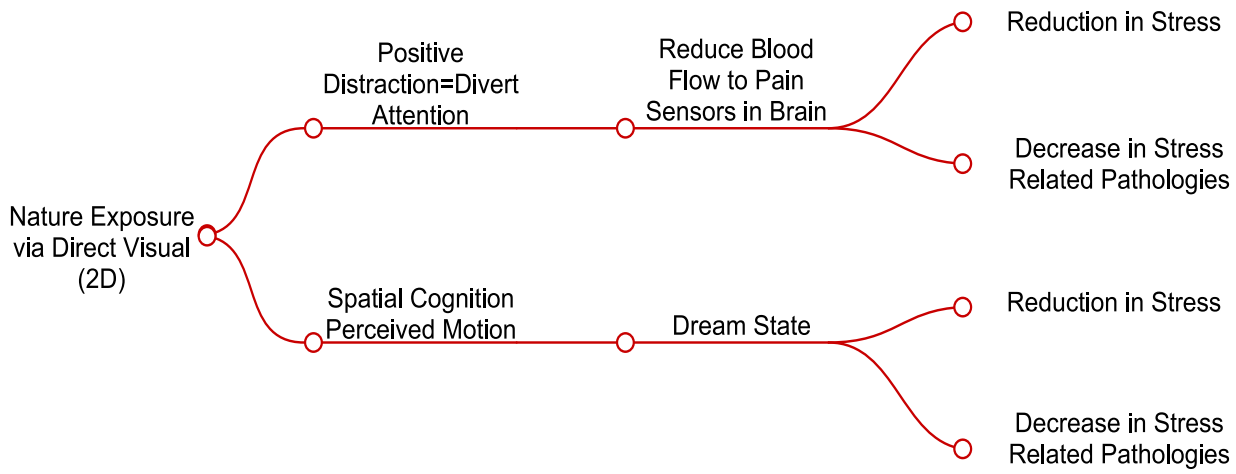

Figure 3: Physiological response to 2D nature exposure in a healthcare environment, Schaeffer Somers & Xuting Jin (UVA MArch '20)

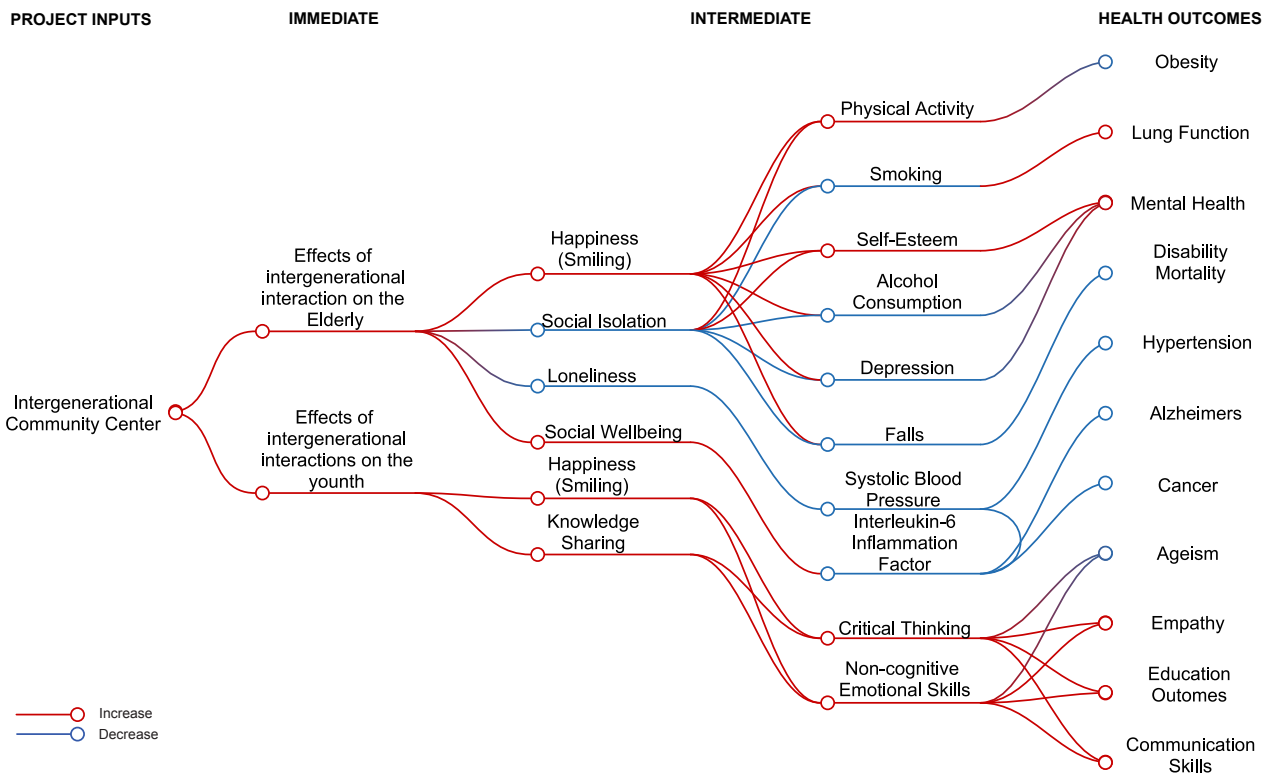

Figure 4. Intergenerational Community Center Design Logic Model, Schaeffer Somers & Xuting Jin (UVA MArch '20).

consequences of design and opportunities to mitigate negative health impacts.

INTEGRATIVE DESIGN

Students who develop skills and interest in this methodology can find many opportunities to develop logic models for projects that are applying an integrative design approach. Sustainability and green building design have been drivers in the applications of integrative design with the US Green Building Council (USGBC) rating system, Leadership in Energy and Environmental Design™ (LEED), promoting decision-making to achieve a set of continuously evolving outcomes related to building performance. The credit for Integrative Process in the LEED Building Design & Construction system incentivizes comprehensive approaches to the design of building systems to find synergies that can achieve higher levels of building performance, human comfort and environmental benefits.[14] USGBC references the American National Standards Institute (ANSI) Consensus National Standard Guide-Design and Construction of Sustainable Buildings and Communities, which identifies requirements for the design and construction industries to engage in a process of identifying interrelationships and synergies between systems and components including technical and living systems to achieve high levels of building performance, human performance, and environmental benefits. The integrative process of LEED and other approaches is modeled on iterative methods and feedback loops versus a linear process, which is reflected in the way most studio pedagogies are framed.

The Delos company has created an alternative accreditation system called the WELL Building Standard™ (WELL), which seeks to certify environments through a similar rating system as LEED organized around seven categories of health.[15] In addition to building registration and certification, both LEED and WELL promote markets for "Accredited Professionals" as part of their proprietary ratings systems.[16] [17] One goal of accreditation is to integrate Evidence-Based Design into the standards to obviate the need for open-ended research methods and make health-based outcomes more accessible to project teams that may lack experience in public health and scientific research. However, the value of logic modeling should remain relevant to the planning and evaluation of projects that use performative measures of health outcomes from their conceptual beginnings. Undertaken as a collaborative process, the modeling approach can assist designers in translating knowledge and terms between related fields in an integrative design setting.

A partnership of the RWJF and USGBC[18] has resulted in a pilot credit for Integrative Process for Health Promotion to support "high performance, cost-effective and health-promoting outcomes through an early analysis of the interrelationships among building systems" and to "facilitate

a systematic consideration of the impact that project design and construction have on health and wellbeing (including physical, mental, and social impacts."[19] This credit attempts to incentivize collaborative processes modeled on HIA without requiring the implementation of all of the steps of an HIA that meets the practice standards. To the extent that the credit becomes a popular target for projects seeking LEED accreditation, the market for designers with skills in research and assessment will continue to grow.

CONCLUSION: OPPORTUNITIES FOR LOGIC MODELING

In the film, Field of Dreams, the protagonist hears a voice in a cornfield that tells him "if you build it, he will come."[1] I use an image from the film of the baseball field in a lecture to highlight the problem that we (as architects) often assume that if we incorporate a feature or element into a design, that it will automatically be used as we intended. This is a common problem in both academia and practice especially when we are imagining the health outcomes of our work. For example, if we design a park for a neighborhood, we assume the proximity to green space and recreational amenities will generate imagined changes in community health behaviors that will result in population level health outcomes. We can cite evidence for our design intervention, but there can be many external factors why the health benefits will not materialize as we have visualized and rendered in our presentations. As researchers and designers, architects will need new skills in searching, understanding, and being critical of evidence that is being considered as the basis for certain design decisions. We can educate design students to take on a secondary research role with the establishment of core competencies. However, the skill set needed for searching health literature is unique to the domain and requires specific instruction and practice. Some of the more user-friendly search engines, Ovid/MEDLINE and Web of Science, require academic access or a subscription, which may represent a barrier to integrating research into practice.

Peer-reviewed, scientific literature has a clear role in architecture education and practice as the program and scope of

Figure 5: Interior, restorative spaces of an Intergenerational Community Center for Orlando. Design by Andrea Gomez Merino (B.S. Arch '18), Zazu Swistel (MArch '19), Anna Morrison (MArch '19), and Sarah Pate (MLA '19).

the architectural project expands to deal with more complex problems. Architects engaged in integrative or evidence-based design practices need tools and resources to translate scientific research into a form that is easily assimilated into more intuitive and aesthetically driven approaches to design. The logic model builds on an established methodology of visualization in the field of program evaluation as well as architectural methods of abstraction through diagramming. Example 2 illustrates how a logic model can be used to clarify and connect relationships identified in separate research studies. However, the value of the logic modelling approach goes beyond its ability to represent causal relationships over time. The process of synthesizing the causal pathways is a vehicle for transdisciplinary work since modeling the causal relationships of inputs like the program of an architectural intervention quickly crosses the boundaries of multiple disciplines and field of study as illustrated in Examples 1 and 3. The adaptation and practice of logic modeling will result in improved design and health outcomes, which can be measured and monitored. The approach can also assist more established Post Occupancy Evaluation and building commissioning protocols. Methods and tools for understanding and visualizing complex relationships will become increasingly important as the design of the built environment incorporates multisensory, cognitive, and mental health outcomes in addition to environmental and social determinants of health.

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