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Diana Susan Nicholas, Samantha Stein, Thanh M. Nguyen,
Elise Krespan, Dylan Tracy, Yvonne Michael

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[1]Drexel University, Philadelphia, PA

ABSTRACT: The Health Design Research Innovation Project (HDI) is a program of interdisciplinary research and coursework exploring urban health and environments through the processes of human-centered design leading to innovation. Supported by a local foundation, HDI is entering its third year of a four-year pilot and involves collaboration between design research and public health faculty. This work integrates social determinants of health into the consideration of design solutions for housing insecurity and urban living environments. Scale, economics, and resources are factors in the built environment that influence the health of a space, especially in urban settings. The faculty here have developed a research program, including an interdisciplinary course piloted spring 2016, which examines how Health and Design research inform innovative thinking for behavioral health in underserved communities, especially around topics such as eviction, shelter and wraparound services. This program is predicated on the struggle of a society with multifaceted health challenges. These challenges now require knowledge contributions from multiple disciplines (O'Campo 2012). The HDI Program seeks to challenge and train students to meet these new challenges.

KEYWORDS: Health Research, Social Justice Design, Advocacy, Housing Insecurity, Design Research, Culture of Health

INTRODUCTION

The Health Design Innovation Project (HDI) integrates social determinants of health into the consideration of design solutions for housing insecurity and safe-space environments. Scale, economics, and resources are factors in the built environment that influence the health of a space, especially in urban settings. The standing faculty have developed this program to inform new ways of creating actionable research and innovative thinking with regards to housing insecurity. Focused on the effects of housing insecurity on behavioral health in underserved communities, the team works to co-design solutions and tools pertaining to topics such as eviction and wraparound services, with community providers in this area. Complex challenges in the urban environment now rely on inter-professional collaboration for change (O'Campo 2012) and inter-sectoral healthcare approaches (Lindau et al. 2016). To take on the massive challenge of reforming healthcare strategy to address complex health needs, thus creating a Culture of Health, the Robert Wood Johnson Foundation's Culture of Health program calls for an expansion of responsibility uptake, or intersectoral health accountability and subsequent interdisciplinary collaboration to develop and implement comprehensive healthcare strategies (Lavizzo-Mourey 2015). As a group dedicated to this secular, robust vision of health realized through healthcare, the HDI team seeks to co-design with stakeholders in the many social and environmental spaces tangential to physiological and mental health. Accordingly, new players are inaugurated as healthcare professionals mobilized to care for systemic forces which contribute to health.

The HDI endeavor has become a year-round research project with housing insecurity at its center, beginning with the Health and Design Research course. The course guides students through an examination of the relation between the built environment, health, and behavioral health issues, linking these issues to the over-arching theme of housing insecurity. Students gain insight into the complex, multi-directional relationships between health and housing insecurity, and are compelled to form novel conceptualizations of health which contribute to the research and roles of health professionals. HDI faculty have developed a process of design research and thinking paired with a public health perspective which aids students in developing such novel conceptualizations. Social determinants of health and the "Knowledge Transfer" needed for meaningful impact on health were the main frameworks that the course examined as a way to create empathy-based research and solutions around housing insecurity.

The HDI project is marked by four cycles, the iterative phases in each cycle include the Health and Design Research course, funded research continuation, implementation, and examination of idea sustainability. Three student driven research projects have emerged from this cycle. To motivate the development of student ideas to take forward into the funded phase, and eventually implement, is a major course direction. Three groups emerged in the second-year course phase of this design challenge: Map the Gap, Therapeutic Expressions, and Data Linxors. Map the Gap examines the relationship between renters, those that own the properties rented, and community-based organizations as a way of reducing evictions and decreasing the burden of home disrepair. Therapeutic Expressions examined community building in shelters, and different artifacts that could be designed within a shelter to build such community. Data Linxors worked through a solution to link the different types of information that care providers, within the space of housing, need. Each team worked closely with community partners operating in the housing and/or health space. This paper will document and discuss the current outcomes and future directions of these three projects. Additionally, it will examine current thinking on such interdisciplinary nonprofit built environment work and speculate on the ultimate outcomes for those in underserved communities.

1.0 THE BUILT ENVIRONMENT SHAPING CAPACITY, SHAPING QUALITY OF LIFE

The motivation to create and sustain real change is a function of three factors. The first of these is dissatisfaction with the current state. This is followed by the articulation of a clear vision that includes a statement of what is possible. Finally, an organization must take the first concrete steps toward achieving the stated vision. (Beckhard 1969) All three factors must be present in order for an organization to overcome its natural resistance to change. (Chaney Jones 2014)

In our urban built environment, services and care are provided in part through nonprofit organizations that supplement government services and shape the lives and spaces of many underserved residents. Design and the consideration of how to provide these services for those with a lack of housing or housing security often takes a back seat given nonprofits' capacity and resource challenges. Many nonprofits in this space are overwhelmed with demand, and struggle to create change. Their survival is often predicated on their ability to continue to build capacity through raising funds and serving the often overwhelming demand for their services. In part due to the fact that they operate as partners in the social service space (Kapucu 2012), the lack of capacity can be understood in the literature on nonprofit capacity. The projects touch on issues of infrastructure and question how the decisions made in terms of the infrastructure of care can make such care more efficient and more comprehensive. Projects elucidate gaps in these networks of care, and the stakeholders who inhabit those gaps. In addition, the projects seek to strengthen and support the already positive culture evidenced within the community providers' efforts. One example of such reinforcement is the identification of opportunities within the shelter system to create community, and the co-design of tools which leverage that potentiality for community connections.

Many of the decisions that can shape the built environment for the better emanate from the research done by public health practitioners. As a practice, public health is "dedicated to fulfilling society's interest in assuring conditions in which people can be healthy" (Abrams et al. 2012). This mission is accomplished by assessing health, developing programs and policies to improve health and reduce disease, and working to assure access to equitable systems of care (Handler, Issel, and Turnock 2001). Historically, public health practitioners and researchers [epidemiologists] understood health to be a function of the places in which people lived and worked. This is illustrated through the well-known example of Dr. John Snow, father of Epidemiology, who mapped cholera deaths in 1854 London and identified a specific water source as the cause of the clustered cases, establishing that contaminated water, not air, was responsible for the deadly outbreak (Snow 1991). Many early public health interventions addressed aspects of the built environment that resulted in disease, for example mandating street cleaning, trash collection and water and sewer systems in cities to prevent cholera and other diarrheal diseases. As a result of these public health measures, these infectious conditions, which were among the most common causes of deaths prior to 1900, were no longer among the top contributors by 1950, replaced by chronic conditions such as heart disease and cancer (Armstrong, Conn, and Pinner 1999). Today mental illness is one of the largest contributors to the global burden of disease through stress (Vigo, Thornicroft, and Atun 2016). In developed nations, chronic diseases and mental illness are most prevalent among the poor (Wilkinson and Marmot 2003); and, the poor's access to sustainable and suitable housing options can drive the population's health in unexplored ways.

2.0 PUBLIC HEALTH, DESIGN AND INNOVATION

In the 2016/17 HDI project cycle students used both a combination of social determinants of health, and cultural and socio-economic research to understand the problems they were addressing. As stated above, three groups emerged in the second-year process of this design challenge: Map the Gap, Therapeutic Innovations, and Data Linxors. Map the Gap, worked with community providers to examine solutions to the

historical tensions between renters and rental owners, as a way of decreasing evictions. This group has received a seed grant from the university's center for neighborhood partnerships and is exploring entrepreneurial support for the tool the team is developing based on its human centered findings. The faculty continues to advise and work with the group as it launches this endeavor. Therapeutic Innovations seeks to work on community building in shelters through design. Working primarily with one community provider, the students connected to one particular shelter in West Philadelphia. This shelter is for single mothers and their children, with a mission to nurture families, strengthen neighborhoods and drive change, and will become a course focus in the next cycle. Data Linxors examined how to link the different types of information that care providers within the space of housing need. The Data Linxors project focused in part on a group of non-profits convened to coordinate multiple services and deliver quality repairs in a more cost-effective manner. Data Linxors is currently under consideration with a larger group of partners. The 2017/18 course and projects are being planned with a focus on shelter projects, and a new community partner, a city organization focusing on those returning from incarceration.

The projects followed a research-driven, human centered process that began with an examination of how social determinants of health influence the lifelong health of urban dwellers. This section will describe a two-phase process each team followed. The goal for the projects was to gain traction, create change and launch a third independently-driven phase. Essentially the two phases described here follow a design research methodology that builds on human centered design methods with public health knowledge and secondary research. Design research methods produce projects that can range from the extremely speculative, to outcomes that have a specific environment, object or service orientation. A 2012 article on this subject defined Design Research as: "a subset of research activity…a kind of empirically-oriented and "applied" approach to knowledge discovery and creation." Ultimately, what defines this novel process is a consistently evolving relationship between processes of design, and processes of research, a type of informed and studied iteration

In the professional realms of design practice, design research can create new understandings of the market or the client. From a manual called the Designer's Guide to Research, "Research frames the problem. It provides context. It helps us get to know the people we're designing for, and the issues we're designing around…." (O'Grady & O'Grady 2017). As it is defined here, the research process allows teams to engage with community providers and community members and truly hear and act on their needs and situations. A variety of techniques are deployed to create overt opportunities in which the teams learn how to integrate and innovate around the needs of these underserved groups. The below listing and chart gives a sense of the paths followed in service to these projects, and expresses the frameworks that the teams used to create their innovative solutions.
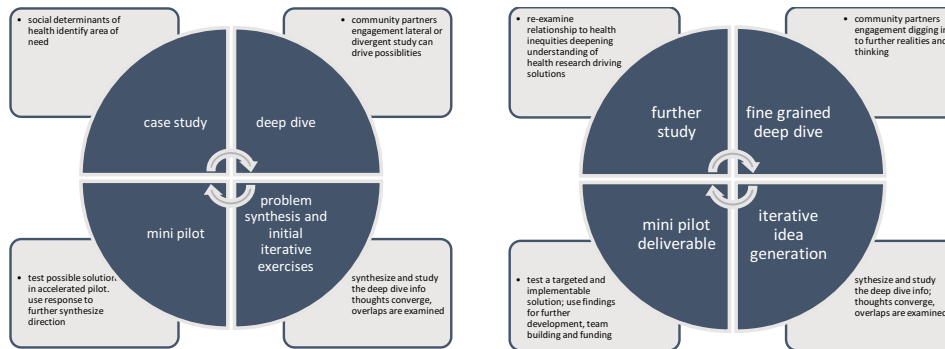
Tables 1& 2: Phase 1, course driven development;   Phase 2, Research driven development

2.1 Phase one: Course Driven Projects
The projects commenced with a course driven design process as follows:

- Case Study: The course is convened with a case study and multiple formal meetings with community groups to understand their needs. The Social Determinants of Health framework is explored and used to identify an area of need within the boundaries of what each community member has shared.
- Deep dive: Community partners' and students engage, students then commence a study of possibilities that can drive new solutions.
- Problem synthesis: Utilizing their community engagement and initial findings, student teams synthesize a human informed problem statement and initial directions for solutions. They continue to study research data to examine how ideas converge and overlap.

- Mini pilot: The students produce and test possible solutions in an accelerated pilot, using the responses to further synthesize directions for their projects.

2.2 Phase Two: Research Driven Projects:

In the second phase of work, further study is commenced with a series of "anchors' or student leads selected to continue work over the summer. These anchors re-examine the relationships to health inequities and work to deepen their health research driving solutions through the following processes:

- Fine grained deep dive: The teams engage with community partners and cultivate more meaningful relationships with these community partners to gain a more fine-grained level of understanding. In addition, they continue a review of scientific literature. Teams also engage in many more iterative idea generation sessions in a targeted way around their challenges.
- Synthesize and study the deep dive information, thoughts converge, overlaps are examined
- Mini pilot deliverable: The teams then test a novel, targeted, and implementable solution; use findings for further development, team building and funding.

3.0 PROJECTS FOR CHANGE IN THE HOUSING INSECURITY LANDSCAPE

The projects described below were developed in these two phases, over six months and have yielded a variety of outcomes. Project work and research on each is ongoing, and as students rotate out due to graduation or life circumstances, new team members are identified. The hope is to sustain the community relationships, student teams, and design research process in order to maintain continuity and continue to create value and solutions in collaboration with the community partners.

3.1 Data Linxors

Data Linxors was conceived as a tool to mitigate limitations to communication and organization between agencies in the health and housing space. The team's process revealed that each community partner was using their own assessment tool. This had created a complex set of issues around the partnership needed to coordinate the data gathered from assessments to mobilize action. The community groups rely on this data to provide their services; however, sharing data was resource intensive. In seeking to demonstrate the benefit of the partnership anticipated to help scale up the reach of these organizations' individual services and combined capacity, Data Linxors found that streamlining data collection and using the combined information to allocate resources appropriately could possibly improve efficiency and efficacy. Long run outcomes the group hopes to accomplish include: Reduced resource waste; improved organization of resources; less overlap of services, better distribution; better communication; reduced wait times; and, better health outcomes.

The project developed by a three-person student team was designed to creatively resolve the informational conflicts and blind spots between several community providers/partners. The premise of this general research area is to develop a project with a "beginner's mindset," in other words keep an open mind. The student team conducted thorough background research work. The team found examples of other projects designed to link data, explored the needs of the users through informal focus groups and in-depth interviews, and engaged with the community providers in a professional manner. The practice of informed design requires that data or research is used to, in part, decide the direction of a project (Chong, Brandt, and Martin 2010). This is an important part of both design research, and human centered design. In this work, it is important to allow the research and in-person user centered interactions to drive the formulation of the problem, as well as possible solutions (IDEO 2011). The group used informal focus groups, expert interviews, and on-site observations of care providers to create a set of recommendations to better coordinate data collection and use. As the team continued to work towards possible solutions, it identified two main challenges to this work: first, overcoming differing cultures including those between students, faculty, and the community groups; second, all nonprofits are challenged to create any change in the face of their overwhelming need to serve immediately.

The continuation of Data Linxors extended the learning experience and developed a possible solution to inter-agency communication. The collaboration between students and community stakeholders made the development of the idea possible. Without interdisciplinary thinking and collaboration, and the cooperation and participation of the community stakeholders, none of the projects developed in this class would have happened. This collaboration, interdisciplinary practice, and introduction of design thinking to students not familiar (to it) make this course a valuable learning experience and give this course the potential to be a valuable asset to the Philadelphia community. Elise Krespan 2017 HDI Student and Project Lead for Data Linxors
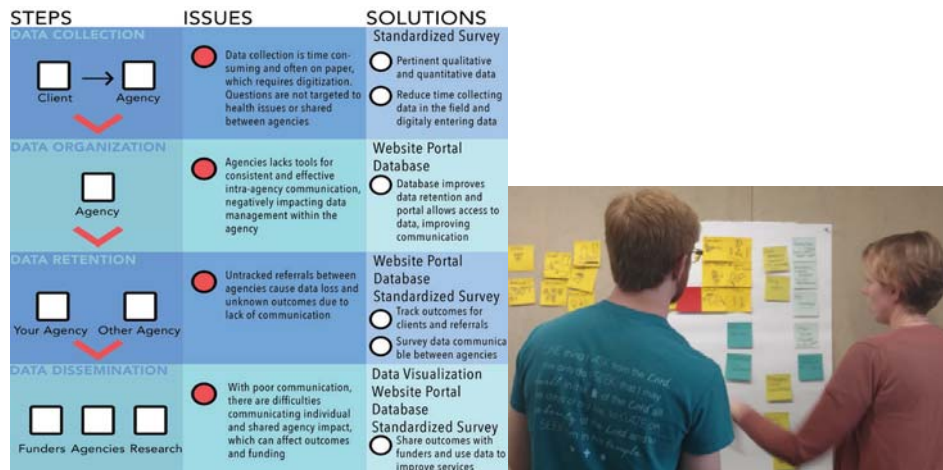
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Figure 1 & 2: Initial Research Map Data Linxors & Student team at work (Authors 2018)

3.2 Therapeutic Expressions

The students in this group focused on the multiple definitions of privacy and their unique and practical applications. The team identified what privacy, and a lack thereof, mean to a West Philadelphia shelter and its residents, and elicited the parties' respective perceptions of the space. The group came to this area of study after visiting with local shelters and entering discussions with care providers who served as community partners to the class. They also examined the mental health risks and service needs of minors and young adults (ages 0-18 years) living with one or no parents, and recommended strategies to prevent the developmental delays and major behavioral problems that are associated with overcrowded shelters in Philadelphia, PA. The team wondered, can a sufficient level of privacy for mental health be obtained in crowded conditions? Privacy is a perception ultimately, the team concluded, so many design features may improve privacy without reducing the number of people in a room. The perception may be changed visually with the use of curtains or mirrors or it may be changed on an emotional level by allowing customization and a sense of control within the given space. Thus, many approaches can be used to improve the perception of privacy through the use of design resulting in better aesthetic and public health. The team also identified rules and constraints such as codes, safety and funding regulations which restrict such privacy tools in shelter spaces. Students studied enforcement and perception of the constraints and realized that the perception of what was required differed slightly from the reality. Furthermore, the team worked to understand the social dynamics of the shelter between residents and between residents and staff. The team also worked with the shelter to understand other constraints such as budget and capacity.

The community partner, identified a lack of privacy in its emergency housing for women and children. The conditions of the housing, mediated by perception, may modify the effect of the trauma these women and children have already experienced, and may help to mitigate poor potential mental, physical, and emotional health outcomes. Privacy directly impacts the women's health, resilience to trauma, and their pursuit of future housing with the provider. Also, employees and volunteers are directly affected as they are the implementers, and as such these changes may affect elements of their day-to-day activities. Finally, the surrounding community as a whole may be affected as the provider could better serve more families, and these families could each have a better quality of life and thus build the capacity to positively contribute to their communities. The goals for the project evolved to include an improved perception of the environment among residents. The team developed and presented to the agency leadership several concrete workable solutions for the shared sleeping areas and continues to develop ideas and solutions. The hope is that an improved sense of privacy will directly reduce the frequency and/or duration of anxiety and depression episodes, prevent incidents of aggression (arguments and fights), indirectly improve academic performance in children, and allow for faster transitions to permanent housing.

3.3 Map The Gap

As a researcher who pursues human-centered design as a lifestyle, I am constantly trying to live more ethically. This class has afforded me new ethical perspectives (such as my realization of the complexity of stakeholders as comprehensive beings) and has given me the tools through which to bridge theoretical ethics with pragmatism (understanding that it is okay to implement ideas so long as it is understood that they should be iterative and thus constantly reformed to address consequences). Samantha Stein 2017 HDI Student and Project Lead for Map the Gap

Map the Gap is a decision-guidance tool intended to facilitate inter-sectoral collaboration between tenants, landlords, Community Based Organizations (CBOs), and other resources in order to address a novel, robust picture of health. As a way to map and bridge the gap between individuals and CBOs (which result in chasms in care) while influencing social norms for improved community health outcomes, the student group created an initial decision tree. Although the group has only created a PDF prototype thus far, they plan to produce a digital prototype for use and testing in the university's center for neighborhood partnerships. It is hoped that this prototype will eventually contribute to a smart, multi-level-data-informed digital user interface to provide housing system navigation guidance to residents of an underserved neighborhood nearby. As an endeavor in human-centered design, this decision tree will attend to the community's unique population of stakeholders. An effort in re-envisioned public health promotion, Map the Gap deploys user-centered design to address housing inequity as a constituent of poor health.

The common problem identified by each group member at the beginning of the course was stress related to home disrepair and subsequent health de-prioritization. The phenomenon primarily affects low income families. Due to low socioeconomic status, these families are considered vulnerable. The project is aimed at increasing empathy and thus decreasing tension between renters and rental owners, improving self-efficacy, increasing capacity to repair homes and influence housing policy, and increasing efficiency of interactions with CBOs. This project seeks to examine and engage with questions such as: "How can disadvantaged families prevent home disrepair?"; "What resources are available to promote home maintenance skills among low-income households?"; "What are feasible coping strategies for living in a home with risks to mental and physical health?"; and, "how can a community lacking financial resources leverage local resources to collectively address the implied warranty of habitability to realize safe, healthy homes?" A rental owner has an obligation to maintain habitable (safe, sanitary, and fit) premises. If such an obligation is broken, the tenant may be relieved of his or her obligation to pay part or all of his rent until the necessary repairs are made. The rental owner must be given notice of needed repairs and a reasonable opportunity to make repairs. Rental owners must repair any material defects to a rental property which affect health or safety of the occupants prior to renting and promptly upon notice during the lease. However, in a deprived community with many accidental landlords, such a responsibility is often overly burdensome on rental owners leaving all parties strained; the system itself is sick. Acknowledging this, the team sought creative solutions to inaugurate a healthier system which leverages existing infrastructure.

An initial problem statement for this group was: "Why do tenants deprioritize health in the face of unsafe housing?" Students discovered a concept called the *Bee Sting Theory. Bee Sting Theory* posits that low-income individuals deprioritize housing repair because any one fix is deemed trivial, and all fixes simultaneously are unaffordable. Accordingly, no fixes end up being executed. As a result, individuals stay sick and cannot direct funds to get better (Bennett 2008). The team recognized larger systemic factors that play into de-prioritization, such as a gentrification, housing discrimination, low financial literacy, and social norms ("Understanding Poverty; Is Economic Theory Wrong? - Opposing Viewpoints in Context" 2007). A user centered deep dive was then conducted to understand the perceived responsibilities of community based organizations (CBO) operating in the Mantua area. It was discovered that CBOs perceive one another's responsibilities differently than each CBO perceives its own responsibility, and that gaps in continuity of care exist within the system as a result. The project currently questions the origins of differences in responsibility perception amongst CBO's and ideates on ways to find shared value and align incentives to create a comprehensive, navigable, efficient, and effective care network.

> At the end of this course, I saw a lot more of the "human" part of the human-centered design [HCD] process. I have been working mostly by myself or with experts on my thesis, so it was refreshing to collaborate with other group partners and multiple stakeholders. It showed me that the "human" part of HCD isn't limited to populations of interest. I found myself being more open to ideas and learning to adapt to others' work styles…we would constantly bounce ideas off of each other. Most importantly, working in a group put a slight pressure to work 110% harder, since others depended on my efforts. I was able to sympathize [with] and understand others' points of view. In all, even though I'm more than familiar with design research, reliving it through the lens of group interaction surprised me…Thanh M. Nguyen HDI Student and Project Lead for Map the Gap

During the three-month period following the end of the class, the group initially aspired to develop a workshop outline and plan for implementation (a mini-pilot in the following term) to improve renter/rental provider dynamics. The group sought a series of expert interviews and attended a focus group intended to grant insight into the experiences of people living in the Mantua region. Ultimately, however, the group's deep-dive led to further questions and an extensive research process. Although the team ultimately opted to pursue a digital

decision-guidance tool rather than a workshop given the need to respect autonomy, cultivate capacity, and attend to limited time-affordances. The digital interface will be continually user-informed and will thus be conscientious and accommodating of what is typically perceived as nuance. The students' work demonstrates an appreciation of the criticality of redesigning healthcare strategy to address the complex, sometimes obscured, underlying social issues which determine the experience of health and the built environment. By leveraging the need for housing system navigation guidance, the project seeks to promote equity, and thus to address health as an experience as a culture which exists beyond individual clinical healthcare. The group seeks to frame housing, and more substantially, equity as key components of a reformed healthcare strategy and constituents of reimagined health.

Initial ideas for expansion of the decision tree developed by the group included the development of a digital interface, potentially a mobile phone application, entitled Map the Gap, which will expand on the idea of collectively addressing cultural tensions, connecting people to resources, and providing highly personalized housing system guidance to Mantua-area residents through an interactive data synthesizer. Although specializing in addressing the local community's needs and navigating city resources, the group would like the resource to be open-source so that the software may be adapted and maintained for use in other cities. It is also imperative to be transparent with users so that they can feel secure knowing how all data inputted will be used, and so that they may assist in the design process beyond the initial deep diving/early development phase. As reducing inequity falls under the category of health promotion, it is applicable to apply the core tenets of healthcare to the project's social health goals, namely continuity of care, autonomy, and sustainability. By applying these core tenets to its healthcare strategy design, the group aims to promote a culture of health, as defined by the Robert Wood Johnson Foundation: "…that everyone has a fair and just opportunity to be healthier. This requires removing obstacles to health such as poverty, discrimination, and their consequences…" ("What Is Health Equity?", 2017). This tool-based solution, as identified by the group through their research, is intended to be accessible to community members at any time. The team has received seed funding through the university's center for neighborhood partnerships and will convene focus groups facilitated in the community center, to gain a better understanding of community digital usage habits and the granularity which informs such habits. During this next community engagement funded cycle, the team will arrange to provide participants with resources and advice from local experts to help address repairs, building trust between the project team and the community. These focus groups will invite community members to co-design an initial prototype which will serve as a proof of concept. While the final digital outcome of the project is yet to be determined, Map the Gap aims to help inaugurate a sustainable, equitable dynamic which constitutes housing as part of a culture of health. Additionally, Map the Gap will continue to seek funding to continue development and piloting of the proposed solution. The team's current seed funding will provide crucial information to inform the next grant application. Today, the team works to promote continuity of care through the cultivation of the digital interface, Map the Gap, which bridges renters, rental owners, and CBOs.

Upon doing a stakeholder map in class, I was instantly overwhelmed. People, I realized, are far too complex to be simplified to the labels we so commonly slap on. We are all intertwined, multifaceted stakeholders. And we must be treated as such if we are to thrive as comprehensive, holistic beings. We must be treated as such and treat others as such if we seek universal understanding. Samantha Stein, 2017 HDI Student, Map the Gap Co-lead

CONCLUSION

The Health Design Innovation Project (HDI) is entering its third year, and the goal to launch these team driven, and human centered projects is coalescing. Developed and supported through such emerging community partnerships, these relationships continue to build in strength as they also grow in efficacy. As aforementioned, scale, economics, and resources are all factors in the built environment that influence the health of a space, and the experiences of the space's inhabitants. Team-driven capacity building is also emerging as a salient topic for exploration. The yearly course and team research is an endeavor that will continue to build on the relationships, and findings to implement these new solutions. This next year the group will focus on two of the community partners with clearly articulated problem statements. The team will also continue to identify partners with a base level of capacity in order to assure they have the resources to work with the students through the initial cycle of the course. Community partners must have sufficient resources to move the proposed solution forward as appropriate, and the group is currently engaged in discussing these possibilities with several community partners. As an advocate for new solutions through human centered design, HDI will continue to explore the themes of capacity building with partners through the projects.

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