Design for Homeless (DfH): A capstone experience

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Abstract
Capstone projects are usually designed to promote critical thinking, problem-solving, and creativity using the knowledge and skills students acquire in their coursework. This paper presents the initial findings of a two-semester-long, industry-facilitated, and collaborative capstone project in Spring and Fall 2018. A team of construction management and interior design students at California State University, Fresno was tasked to design and build a temporary home prototype for a local homeless shelter to raise awareness of an urgent social and economic issue in the community. The new design aims to create a more comfortable and uplifting environment for the homeless. The project provides an immersive interdisciplinary learning environment with a tangible scope, featuring direct mentorship of faculty and a local architect, collaboration between two colleges, and active interaction with a non-profit organization. The project is evaluated based upon information gathered from student design artifacts, construction process documentation, and perceptual data via surveying and reflection. This paper discusses the benefits and unique challenges of Design for Homeless (DfH) and provides insights on its implementation as a capstone experience.

Introduction
Capstone design courses are intended to provide rich opportunities for student learning [1]. According to Marin et al., successful capstone experience can be affected by many factors, including student preparation, the type of project selected, and the roles of mentorship [2]. A study conducted by Todd et al. revealed that a significant number of institutions engaged industrial clients to sponsor capstone projects [3]. In addition, a number of schools were using undergraduate team-based projects, with a few using interdepartmental undergraduate teams from different disciplines. This study discusses a senior capstone experience featuring multidisciplinary collaboration between construction management and interior design students on a service-learning project that addresses design for homeless. The project involves a broad spectrum of stakeholders including architectural and construction firms, non-profit organizations and other community partners. Student learning outcomes are assessed to offer insights in understanding how such a capstone experience may have the potential to provide tangible benefits to both students and the local homeless community.

Background
According to the US Department of Housing and Urban Development's Annual Homeless Assessment Report, as of 2018 there were around 553,000 homeless people in the United States on a given night, or 0.17% of the population and about one-third (35%) were unsheltered. Noticeably, California has the largest homeless population (24% or 129,972 people) and the highest percentage of unsheltered homeless population (68.9% or 89,543) [4]. Small temporary shelters offer respite from the homelessness crisis and relief for the users, providing them with a safe and private environment, protection from the elements, and a shield from the vulnerability of living in the street [5].

The Department of Construction Management at California State University, Fresno has a well-documented history of commitment to address homeless issues in the community, and has been
dedicated to seeking innovative and affordable shelter design and construction solutions via service-learning and active collaboration with local architecture, engineering and construction (AEC) firms. The Eco-Village project [6] documented efforts of students from two colleges (i.e., Lyles College of Engineering and the College of Arts and Humanities) who were tasked to design and construct meaningful emergency housing after investigating various conditions harming the homeless population in local community and elsewhere around the world. This unique experiential program allowed students the opportunity to develop the knowledge, skills, and attitudes necessary to gain social, cultural, and environmental consciousness in both their professional and personal lives. In the long term, the program is staged to design for the needs of a community it will serve. Another unique project in the department, entitled the “$300 House Challenge”, explored the technological and social dimensions of lower-division student learning in engineering and construction curriculum, via a design for homeless shelter with $300 budget [7]. This uniquely blended technological and social context became a facilitator to enhance student learning outcomes (SLOs) in teamwork, collaboration, communication, and leadership, which are deemed as essential social competencies of future workforce.

Existing literature about student design of shelters is broad, but there is a lack of studies in this area involving multidisciplinary work. In addition, studies rarely explore the impact, during and at completion of a project, on students who designed and built a temporary shelter prototype for chronically homeless people. In a study from 2017 [8], interior design students at a university designed and tested a prototyped portable homeless shelter with six homeless men in order to gain a better understanding of the design needs for portable homeless shelters. The project had a different focus compared to the study presented in this paper, as it did not involve collaboration with other disciplines, nor did it assess the impact of the project on the students.

The Capstone Project Design and Implementation
This was a two-semester-long capstone team project for a group of four (4) senior construction management (CM) students. The team was tasked to design and build a temporary home prototype (single or double occupancy) for a local homeless shelter to raise awareness of the homeless crisis in the community. In phase 1 (Spring 2018), the initial design concept of the shelter prototype was presented to the team by a local architect in the form of a paper model and a preliminary floor plan. The team then worked closely with the architect and the instructor to develop detailed design plans, digital models, specifications, along with a milestone construction schedule and a material cost estimate for the project. In phase 2 (Fall 2018), a collaboration with a class of eighteen (18) freshman interior design (ID) students began. The CM and ID students paid a visit to the homeless shelter together where they observed the conditions of the existing shelters and learned the living challenges and needs from the shelter representatives. Based on the feedback and further literature review, the ID students provided recommendations on interior and exterior paint selections and designed an accent wall for the interior. Meanwhile the CM team constructed the shelter prototype on campus following updated design plans and digital models, a construction safety plan, a work coordination plan, a weekly construction schedule, and a detailed cost estimate. Figure 1 (a) - (d) illustrate the conceptual paper model from the architect, the 3D model created by the CM students, the accent wall design and interior color selection proposed by the ID students, and the final completed shelter prototype, respectively.
The project provides an immersive interdisciplinary learning environment with a tangible scope, featuring direct mentorship of faculty and industry professionals, collaboration between two colleges, and active interaction with a non-profit organization. The project is evaluated based upon information gathered from student design artifacts, construction process documentation, and perceptual data via surveying and reflection.

Figure 1. The evolvement of the shelter prototype

Design Features of the Shelter Prototype
The sleeping units at the local homeless shelter consist of an assemblage of uninsulated tool sheds, which are obviously less than desirable for human habitation. After a site tour and consultation with the shelter director in regards to their needs, safety, comfort, privacy, prevention of bedbugs, and ease of maintenance were identified as the top design priorities.

Consideration of the diversity of users, stressors related to homelessness [9], and geographic location of the small unit provided appropriate interior materials and a color scheme for the prototype. The paint used for the interior including the walls, the ceiling, and the floor was a liquid rubber, a product that is water based, waterproof, chemical resistant, and has low VOC (Volatile Organic Compounds). Plywood was chosen over drywall for sheathing as it is a much stronger material and is less susceptible to cracking in case of transportation. All corner seams and cracks were sealed using an embedded reinforcement fabric provided by the paint manufacturer, which further prevents the infestation of bedbugs, a major problem in homeless shelters. A drain was installed inside the shelter to allow for an easy and thorough rinse-off with a high pressure water hose.
An accent wall emphasized by the design of lines delimiting simple shapes was conceptualized by the ID students as a visual and uplifting distraction [10]. The horizontal lines evoke calm and tranquility and vertical lines evoke stability, strength, and dignity [11]. Students also proposed a variety of accent walls for future design applications to differentiate one shelter from another and to personalize the small units [12].

Psychological effects of colors are difficult to prove since many variables affect them: different responses from one person to another, levels of brightness and saturation of the color, amount and type of light in a space, and the space itself [13], [14]. These variables, in addition to a lack of specific research suggesting colors appropriate for small temporary shelters, made the selection of colors for the shelter challenging. The colors selected by the students for the prototype were based on general agreements of color theories and symbolism, and with consideration for the searing temperature of the region. Students concurred that cool colors seemed appropriate. The blue of the accent wall conveys tranquility and is perceived as receding [8]. The green of the walls contributes to relaxation and symbolizes nature [13], [14]. The gray floor offers neutrality in the color scheme. Gray also delineates the horizontal and vertical lines of the accent wall, creating a visual depth between the simple shapes [15], [16].

The shelter prototype is fully insulated and features an Energy Star certified cool metal roof (SR=0.65, TE=0.87, SRI=70) with a long overhang, which greatly improves thermal comfort in extreme weather conditions compared to the existing shelters.

Since electrical wiring is not allowed in all units at the local shelter due to staff shortage and concerns of fire hazards, students suggested solar rechargeable lights as an alternative. A large sliding glass door was placed at the front entry to bring in abundant natural light. Vinyl curtains were recommended to address issues of light and sound control, privacy, as well as easy maintenance.

When subsequent units are built, it is suggested units be adjacent in orientation, facing opposite directions to increase privacy.

Data Collection & Results

1. Data collection & results from the CM team

   - Direct measures
     As the CM department at California State University, Fresno is ACCE (American Council for Construction Education) accredited, the team project in its capstone series is used to assess one of the ACCE Student Learning Outcomes (SLOs): “apply construction management skills as a member of a multidisciplinary team”. The direct measures include student design artifacts (i.e. design plans and models, specifications), construction process documentation (i.e. construction safety plan, work coordination plan, construction schedule, and material estimate), field execution (i.e. lab reports and field inspections), and progress presentations. Peer evaluation was included for grades adjustments. The shelter prototype was delivered on time and in great quality.
Indirect measures

An online survey was conducted at the end of the project to evaluate how well the overall team project was designed to facilitate learning engagement and students’ attainment of knowledge and skills. All four CM students completed the survey. Figures 2 and 3 below summarize the results from two of the survey questions.

It appears that everyone on the team acknowledged the capstone team project placed a strong focus on “B. Addressing authentic needs and generating real impacts on society and community”, “C. Encouraging sustained inquiry via an active, in-depth process that involved real-world, field-based interaction with experts, service providers and users”, “E. Encouraging student reflection on the content knowledge and understanding, success skills development and the project itself”, and “G. Motivating further development of the project to go beyond classroom but into real products for public”.

Meanwhile, everyone rated either “quite a bit” or “very much” regarding the level of the capstone experience contributed to their development in the following areas: “C. Thinking critically and analytically”, “E. Acquiring job- or work-related knowledge and skills”, “F. Working effectively with others”, “G. Developing or clarifying a personal code of values and ethics”, “H. Understanding people of other backgrounds (economic, racial/ethnic, political, religious, nationality, etc.)”, “I. Solving complex real-world problems”, and “J. Being an informed and active citizen”.

Figure 2. CM post-project survey question 1 results
The survey also included several open-ended questions. The responses indicate that the four students had little to no knowledge about the homeless crisis in the area before taking on this capstone project. They also commented the project was an eye-opener and certainly raised their interests in seeking solutions to help end homelessness in the future.

In addition to the survey, each student wrote a reflection paper where they provided a detailed description of the project. They elaborated on their new skills, knowledge, and/or abilities gained during their experience while also explaining their new perspective on the local community and discussed the benefits and challenges of working in a multidisciplinary team. When finished, the students were able to offer constructive suggestions for future improvements. The feedback from the in-depth reflections align well with the survey results above.

2. **Data collection from the ID class**

A separate survey was conducted in the ID class at the end of the project with 10 open-ended questions. The intent was to assess their overall project experience and the project’s impact on students’ academic, personal, and social development. All 18 students completed the survey. The results indicate that the majority of the class had minimal or very limited knowledge of the homeless community, and over 70% of the class held a negative view towards homeless people before working on the project. However, half of the class acknowledged that the project increased their empathy towards homeless people. All but one student agreed the project made them think about the importance of advocacy for the homeless to raise public awareness. For most students (72% of the class), the project was a transformative experience that opened new perspectives, cultivated new knowledge, and empowered them by giving them the confidence to know they could make a difference. Students noted cooperation with others, new knowledge about the homeless community, improved research skills, and hands-on practices as the
most valuable impact. 90% of the class believed that interior designers should contribute via design intervention to help reduce homelessness. 89% of the class expressed interests in future collaboration with other students, faculty, the community, and local organizations to help reduce homelessness.

Empirical observations of students’ growth, collaboration, and learning also contributed to the assessment. Such observations were made by the instructor from note-taking at weekly class meetings and were based on students’ behavior, teamwork, collaboration with the CM students, presentations, and class discussions. The observations indicated that the project greatly raised students’ awareness about homeless people and their special needs, increased empathy, and provided a platform for collaboration, which supported the results from the survey mentioned earlier.

Conclusions and Future Research
The DfH project was the first non-conceptual capstone team project completed by the CM students at California State University, Fresno after a recent major revamp of their capstone series. The new capstone series allows students to work on one team project over two semesters where they focus on background research and initial planning during the first semester and move on to detailed planning and/or implementation in the second semester. One of the ACCE student learning outcomes this team project attempts to assess is “apply construction management skills as a member of a multidisciplinary team”. Through collaboration with the local AEC industry, faculty and students from Interior Design, and a nonprofit organization, the DfH project presented a real-world problem with profound underlying social and economic factors.

Reflection from the CM students indicate they appreciated the team experience and the fact they were making an actual impact. Same can be said for the ID students. Not everything went smoothly. Project delays occurred due to design changes demanded by the architect, shortage of labor, lack of field experience, wet weather, funding shortage, etc. Communication between the CM and ID students could be challenging at times because of the different class schedules. Students had to constantly adjust their plans, research new materials and products, and learn new skills. They acknowledged that was also the beauty of a real project. The data collected from both CM and ID students showed the research and field implementation raised their awareness about homelessness, instilled empathy and new perspectives towards this community, and shed light on how design and construction could be powerful tools to generate solutions to social problems. Results also demonstrated measurable academic growth and maturity, as well as improved critical thinking.

A follow-up survey will be distributed to the users of the prototype during a one-year cycle to evaluate the pros and cons of the shelter design for future improvements of the prototype. Recommended new studies include modular design for future shelters and design of prototyped furniture featuring flexibility, safety, and sustainability.

References
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