REBUILDING NEPAL:
APPLYING DESIGN THINKING TO SHELTERING IN THE WAKE OF NATURAL DISASTERS.

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Abstract

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My research leverages design thinking to address social and humanitarian concerns in the developing world. These wicked problems have shifting parameters and stakeholders, and by definition have impossible to formulate clear problem statements and singular definitive solutions. My work has focused on the complexity of problems in mobility design, handicap accessibility, and disaster relief in the developing world. After the massive earthquakes and subsequent devastation in Nepal, in April and May of 2015, I returned to contribute my unique skills in construction, architecture and design to rebuild transitional and temporary homes. In conjunction with building efforts, I conducted innovative and novel research in the field in the immediate aftermath, focused on the challenges of delivering and deploying shelters in low-resourced environments.

PACK focuses on addressing the challenge of delivering shelters to remote locations by enabling the rebuilding that is already occurring on the ground using existing materials, often without assistance. Traditional approaches to disaster sheltering focus on providing all-in-one kits to displaced individuals, but as my research
Kevin B. Phaup

in Nepal has shown, various factors limit the success of these initiatives. Deep immersion into resilient communities revealed untapped potential to transform and empower people on the ground to respond to disaster with locally appropriate, vernacular construction techniques. My approach differs by proposing to aid an often-unskilled civilian population to quickly and easily build structurally sound shelters using locally available materials with a portable construction template system. This radically different approach to disaster relief distributes a system for building transitional shelters, rather than the costly and wasteful distribution of numerous tents and prefabricated temporary shelters. The distribution of a single system, from which hundreds of shelters can be built, will be far more effective in reaching the many remote locations, where relief is needed the most.
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Wicked Problem:

“A wicked problem is a social or cultural problem that is difficult or impossible to solve for as many as four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems.” ¹

The following thesis forms a discussion on wicked problems in our world and investigates leveraging and applying design and design thinking to address social and humanitarian concerns in the developing world. Design thinking is now recognized, “through a research-based understanding of the nature of design ability”, as an inherent part of human thinking.² As such, it is a viable and valuable methodology for understanding human-centered problems. These wicked problems have shifting parameters and stakeholders, and it is by definition impossible to formulate clear problem statements and singular definitive solutions. Stagnant progress in these


problems might be a direct result of the fear of change carried out through stubborn and repetitive approaches. Physicist Fritjof Capra, in *The Web of Life*, discusses how new concepts in physics brought about a profound change in our worldview. While grasping this new reality he states, “scientists became painfully aware that their basic concepts, their language, and their whole way of thinking were inadequate to describe atomic phenomena. Their problems were not merely intellectual but amounted to an intense emotional and, one could say, even existential crisis. It took time to overcome this crisis, but in the end they were rewarded with deep insights into the nature of matter and its relation to the human mind.”3 The scientist found that in order to move forward, they had to accept new evidence and abandon what they had believed to be true. Solutions, which produce effective change inside wicked problems, require new ways of thinking and a critical analysis that completely restructures our approach and takes us far outside of our comfort zone.

The case study presented here, which began with deep immersion in the aftermath of the devastating earthquakes in Nepal, outlines my approach to generating potential solutions. Acknowledging that wicked problems are part of a non-linear system, and that in such a system informed innovation can radically disrupt and improve repetitive traditional approaches, drove my process. Capra indicates that in a linear system small change will have a small impact, but in a non-linear system a small change

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“may have a dramatic effect because they may be amplified repeatedly by self-reinforcing feedback.”

In an effort to best construct what the non-linear system might look like, I began by outlining a logical, perhaps typical, linear system to describe the problem. Working alongside affected individuals, I collected and systematically organized data, while continually developing working frameworks to map how systems functions, from stakeholders’ response to embedded knowledge to political, cultural, and regulatory landscapes. Data was continually synthesized and relationships between elements constantly re-envisioned into a non-linear but highly connected system. Design insights, formulated from interconnectivities between data, drove the development of interventions that reconstruct perception, performance, and distribution of traditional sheltering methods. The efficacy of interventions will be analyzed in the near future to examine and forecast potential effects, adoption, and success. Data synthesis led to breakthroughs in my approach to shelter provisioning, moving from a costly and often times ineffective system, which I experienced first hand, to one more adept and responsive built on collective grass-roots action.

The approach embodied in this thesis makes no claims to solve the incredibly complex challenges inherent to disaster response, but rather demonstrates an effort to understand it, reframe it, make progress, and formulate a discussion around it. Through the use of design thinking methodology, this thesis highlights the potential to open up

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new avenues of investigation and inspire a new approach that inverts traditional response mechanisms. In tackling a wicked problem, the designer embraces the failure that naturally constitutes an exploratory, iterative process, and leverages lessons learned towards the next step in progression. The complexity of wicked problems along with the ambiguous nature of design thinking will at times produce a sense of frustration and hopelessness, often depicting a frightening unfairness in our world. However, hope can be found along the way in the exciting discoveries and minor advances achieved through radical new approaches to the problems. Where the success might be better recognized is in the discourse provoked by design thinking rather than the design outcome itself. Design is no longer narrowly defined as the production of an object or service, but is valued and considered as a methodology of thinking, problem identification, and generating never before imagined solutions. This method of thinking evolves design from a “tactical role, to build on what exist and move it one step further, to a strategic role, to create new ideas”.

In order to be truly effective and objective in creating new ideas, designers must recognize the need to disconnect from their established mindset. Mary Clark’s book, *In Search of Human Nature*, writes about how our experiences shape our brain, “… our experiences, not only those in childhood but also as adults, affect the very way our brain functions and the degree of control we can have over our feelings and actions.”

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Designers, who are tasked with solving problems in realms that are completely foreign to them, not just geographically but also in culture or experience, need to be aware of this and make an active effort to understand the problem from a different mindset. Clark further states that, “...one cannot think and act without the meaning provided by (and influence of) one’s culture; meaning involves values; and that values are related to feelings.”

Maybe it is impossible to completely think or act outside of our experiences, but approaching problems with an awareness of this is critical for developing empathy and understanding. To this end, designers must actively maintain an open mind and practice immersive empathic modeling. To think and act from another mindset requires resistance to intuition and acceptance of foreign reasoning. Empathic research techniques might almost feel like an out-of-body experience, one that takes on a culture, belief system, expectation system and worldview that is completely foreign. As the totality of the situation begins to permeate the walls of embedded experience, interconnectivities will emerge between the contributing factors. Unique and interesting connections, that may have presented as completely unrelated, will be critical in identifying the real problems and set you on the path towards appropriate and effective innovation.

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CHAPTER 1:
INTRODUCTION

I have traveled to Nepal twice to conducted field research in 2015. Early research efforts investigated the complexity of challenges in mobility design and handicap accessibility with a holistic approach from service providers to end-users. Through intensive fieldwork in Nepal I initiated contacts, developed networks and cultivated partners on the ground to conduct rigorous ethnography, immersion, co-design and participatory research. I successfully received grant funding from USAID to develop prototypes, and to test those in Nepal with users, service providers, therapists and aid workers. A second trip to continue research in mobility design was scheduled for May of 2015.

On April 25th 2015 Nepal was hit with a massive earthquake that registered at 7.8 on the Richter scale. In the weeks that followed they experienced many major aftershocks and a second earthquake on May 12th 2015. The devastation claimed thousands of Nepali lives’ and left 2.8 million people displaced without shelter and

humanitarian needs. These tragic events hit close to home as I thought of Nepali friends, the people of Nepal, and the beautiful country I had come to love.

Following the massive earthquake and subsequent devastation in Nepal, I shifted my research focus and returned to contribute my unique skills in construction, architecture, and design to rebuild transitional homes. Realizing that this was a unique opportunity to put myself in the middle of a wicked problem and gain first hand knowledge of the aftermath a developing country faces from natural disaster I returned just two months after the earthquakes. In conjunction with rebuilding efforts, I conducted field research on the ground in the immediate aftermath, on the challenges of delivering and deploying shelters in low-resourced environments.

Earthquakes in and of themselves are not major problems. An individual standing in an open field will weather an earthquake more or less unscathed. Instead it is the buildings we build on the earth's surface that are problematic. When they fall, there is an immediate need to shelter displaced individuals as quickly as possible. The truly wicked problem is also not simply defined as how to build a shelter, but instead encompasses the spectrum of challenges in developing and effectively delivering shelter solutions that meet a range of needs. The wicked problem here is intertwined in a societal history of inept, corrupt and unstable government, compounded with extreme

poverty, dependency on foreign aid, limited education, and a culture that responds to these hardships with little hope for improvements or change to their reality.
CHAPTER 2:

INSPIRATION:

“The Problem Or Opportunity That Motivates The Search For Solutions.”

-Tim Brown

2.1 Case Studies

Partnering with Hope Initiative, a small non-profit organization working in Nepal, I established a team and secured funding to support a relief effort. The team consisted of myself, Ann-Marie Conrado, founder of Hope Initiative and professor of Industrial Design at the University of Notre Dame, and Devi Sapkota, co-founder of Hope Initiative. Conrado led the efforts for fund raising and Sapkota and myself planned for a five-week trip to carry out the work in Nepal. In Nepal we were supported with lodging, travel, and labor through an extensive network of family and friends involved with Hope Initiative.

Traveling to Nepal less than two months after the earthquake, the construction of emergency shelters and temporary housing or community spaces were the anticipated actions. In preparation for the trip I imagined an experience that was quite different from the reality encountered. I expected to show up and start building immediately, create new and exciting designs, and for our efforts and expertise to be received with open arms; these attitudes in retrospect were naive. A lifetime of hardship faced by the Nepali people has cultivated a mindset and worldview that is much different than my experience in the United States. I was confronted with attitudes of entitlement, distrust, and skepticism towards our relief aid efforts and expertise, and to foreign relief aid in general. Although I was surprised by this response, I remembered that I needed, as best as possible, to understand their perspectives not only in the shortsighted events of the earthquake but in the greater context of their culture, history, and mindset. What I came to realize is that distrust and skepticism were the result of a culture that frequently experiences and always expects corruption from government, police, military, and even NGO’s and other foreign aid entities. The expectation for corruption has cultivated a survival mentality in which no one is fully trusted and individuals protect themselves by questioning everything and demanding that things be done in ways they are familiar with and understand. In turn, the fear of corruption places walls between indigenous and foreign knowledge, which effectively cripples efforts to inject change through new ideas or practices. My efforts to empathize with and understand the greater context grounding their response allowed me to see
the world as they saw it and opened my eyes to larger needs typically unaddressed in development solutions.

Field research was conducted in a variety of locations to examine damage, conduct interviews, and identify appropriate projects to work on. Our team chose to focus its efforts on rural areas where little to no relief had been received. Three areas were identified with projects of an appropriate scale: a transitional school in the Kavre district, permanent housing in the Kaski district, and temporary housing in the Tanahu district. Response from local villagers and community members varied across these locations.

In Kavre, villagers were difficult to please and persistent in demands for expensive building materials and finishes. Their flawed perception of the extent of our available relief resources presented as unrealistic expectations. Reflecting on this later, it was a sense of expectations cultivated by a lifetime of foreign aid pouring into Nepal. Our team offered to construct temporary schools using locally available materials to provide immediate classrooms for students. Despite the fact that the government will eventually rebuild schools, villagers made demands for permanent buildings and expensive finishes that were beyond the scope of our resources. Needing to stay in the budget, time was spent in an effort to identify available local building materials and demonstrate how these could be used to provide strong, beautiful, and appropriate transitional schools.
Every effort was met with pressure to do more. After a week of discussion and no progress, frustration exhausted our efforts to offer new ideas for building. There was no question that a school was needed, however, of the four buildings that made up the school only one building was marked as safe for use. The villagers were scared to use this building, so school was currently being conducted under a tarp. The compromise reached was to contract the construction of a metal-framed building, a construction style they were familiar with through a post earthquake home built nearby. We designed an open floor plan concept that would allow the building to transition to a community center once the government rebuilt the school, and we acted as a general contractor overseeing the project from a distance.
Traveling to Kaski, the next opportunity allowed us to work with a crew in the construction of what they considered to be permanent housing. The crew consisted of project manager and fundraiser Darshan Lama, a furniture maker, a skilled laborer, a hired female laborer, and local villagers and volunteers. As a construction worker, designer, and academic the days spent here were extremely valuable, and perhaps working with local construction crews should have been the first goal. The crew lacked experience in building homes and, seemingly, no plan existed. The construction process faced challenges at every level from the transportation of materials, limited funds, lack of education, quality of tools, and hot, humid and rainy climate. Challenges in construction often contributed to an underlying negative cultural attitude towards the Nepali villagers’ situation. Additionally, working with this crew provide exposure to the differences in construction tools, knowledge and techniques between the US and Nepal.
Recognizing new layers to the problem, field research efforts placed equal importance on action, observation, and data collection. Field research efforts aided this thesis in the comprehension and identification of the challenges in post earthquake re-construction efforts in Nepal.

The crew in Kaski was enthusiastic about working with us; however, the problem of introducing new ideas through discussion continued to be difficult. Communication difficulties were compounded as parties involved lacked education in construction, including the translator. A firm grip on their building methods and limited exposure to other construction techniques created a tension that resisted any new ideas. The breakthrough in the communication barrier was found through the creation of physical examples that provided a visual learning experience and exposure of new knowledge.
Hands-on demonstration of ideas was identified as critical in the successful development of any future design endeavor. As a foreign outsider, and not part of the hired crew, I had to be very considerate and careful in presenting critical feedback on the buildings being constructed. It would not have been productive to criticize all the work they had done, and though I saw many structural concerns, I choose to focus my efforts in offering ideas and solutions on what remained to be built.

Figure 4. Demonstrating proper methods for stronger bamboo connections.

The last opportunity was in the Tanahu district working with a small rural village that had received no relief aid. Many members of the community desperately needed some form of temporary housing. Our team here consisted of three Pokhara locals, Dipak, Dipesh, and Ramjit, who had been helping rebuild in Nepal since the first day after the earthquake, Sapkota and myself.
In the previous two locations we were working in scenarios already initiated by other social workers and construction efforts, placing our team under their authority. Our team initiated the Tanahu project and the assumption was that we would take the lead and make all the decisions. Shortsightedness and naivety again lead me to the wrong conclusion. I initially thought we could build a better shelter for someone if I could design and lead the project. During the week working in the village I realized that my desire to control the design and construction did not consider these villagers, as I would want someone to consider me. The realization that this is their home, and that they take pride in what they know and believe, was one that resonated with me and that changed my mentality considerably over the course of the week. While empathy is learned in the classroom, the intensity of the need and the experience in Nepal made it
difficult at times to remember these principles. During construction our team united through compromise, acceptance, and value of each other’s contributions. However, working collaboratively was aggravated by something I deemed as the “not-supervisors”. These “not-supervisors” possessed no training in construction, but stood by, watching not working, and shouting rants, suggestions, and criticisms. The locals actively involved in the building process engaged in heated arguments with the “not-supervisors”, which significantly slowed progress and depleted morale in the hot sun. The time spent here was invaluable in further understanding the people, culture, and the challenges faced in re-building. Despite the difficulties in Tanahu, I experienced a resilient community that pulled together to help each other. Furthermore, I experienced first hand the humanitarian differences that shape a culture, including what it’s like to work in a harsh climate with limited food, creature comforts, and hope for change.

Figure 6. Members of our team pictured with the family after the completion of the second shelter.
2.2 Housing Situation

History of housing in rural villages like the one in Tanahu is limited in construction techniques. The 2011 National Census Report for Nepal states, 41.38% of the country’s population lives in houses with outer walls made of mud bonded bricks or stone.\textsuperscript{11} Field research showed that the percentage of primitive masonry building construction is much higher in rural locations. Materials for stone and clay walls are gathered locally and hence come at no cost, are extremely heavy, and generally very stable – as long as the earth doesn’t move. During an earthquake the clay is loosened and the weight of the stones result in structural failure.

![Figure 7. Village home constructed from stacked stone bonded together with clay.](image)

This type of construction contributed to many of the lives lost during the April and May 2015 earthquakes.\textsuperscript{12} The problem for those left homeless by the earthquakes is that there is a lack of skilled labor available to rebuild properly constructed homes. Even if there were more skilled labor, most villagers lack the financial resources needed to undertake the immediate building of permanent homes. The result is that villagers are forced to choose between living under tarp shelters indefinitely, attempting a form of temporary shelter construction that is foreign to them, or rebuild the same types of unstable stone and clay houses they have known for centuries, homes they may now fear.

All over the country, but particularly in the rural areas of extreme poverty, Nepalis are choosing to skip building a temporary home and beginning to reconstruct permanent homes in the exact same way as before. Historically, the highest educated Nepalese see the villagers as blinded by tradition, “and whether spoken of with pity, compassion or derision, what is perpetuated is the idea that the villagers are “incarcerated” in a way of thinking by virtue of being “natives””.\textsuperscript{13} This “blindness” could very well cost many lives. If the buildings are rebuilt in this manner it is inevitable that they will face a similar death toll or worse in future earthquakes.


The news in the US and other nations reported an estimated death toll of 10,000, however interviews with local professionals and Nepali residents estimate the number to be more than twice that amount. The truth is no one really knows. With poor census records and lack of equipment to move rubble, it’s difficult to account for all those who lost their lives. Repetition of construction methods that are unsuitable for geography prone to seismic activity should raise concern for the possibility of history repeating itself. Developing permanent housing solutions to implement and enforce building earthquake resistant housing will take an immense amount of time. Limited

skilled labor and construction knowledge will only add to the challenges of executing proposed solutions. The unfortunate reality is that a complete restructuring of construction in Nepal may never be fully in place.

A more manageable but critical question is helping individuals’ transition to more secure, temporary housing. How can we empower villagers still living in emergency or makeshift shelters to build temporary housing? And how are those entities, foreign and domestic, constructing these temporary houses define what “temporary” means for the majority of those who lost their homes. The solution proposed in this thesis is founded in the belief that education of temporary housing will provide a more sustainable and achievable outcome than the design of a new prefabricated shelter. Providing education of proper bamboo construction techniques and tools that assist in the process will outlast and out reach the distribution of shelters themselves.

Although there are negative cultural connotations towards the use of bamboo in permanent houses (bamboo being seen as a material used by the poor) it is an acceptable material being utilized for temporary shelters. Like the stones used in previous village home construction, bamboo can also come at no cost, as it is readily available for harvest in the surrounding jungle. Building with untreated bamboo is conceived, as temporary from the start, with common knowledge that left untreated the bamboo will rot in 3-5 years. However, during that time frame bamboo is a very strong and light structural material. While temporary bamboo structures don’t solve the need for permanent housing, they are a safer alternative to rebuilding the stack stone
houses. In the event of another earthquake or strong aftershock, a failed bamboo structure is far less likely to suffer a similar death toll as the stack stone buildings in rural areas.

Figure 9. Harvesting local bamboo

Constructing with bamboo builds on an existing knowledge base. The majority of villagers possess some knowledge of working with bamboo for rough construction of porches, livestock shelters, wall finishing, and craft production. Techniques in weaving bamboo surfaces or bamboo and plaster walls were demonstrated in many of the
regions our team visited. What is lacking is an understanding of post and lintel bamboo construction, structures, connections, and building layout.

2.3 Field Research

The problems with rebuilding in Nepal are abundant and it is difficult to summarize them into a succinct and comprehensive list. In addition to the construction of physical buildings, my field research included numerous interviews and collaborations with Nepali professionals in government, construction, education, and architecture as well as with local residents to identify the overarching themes outlined in this section.

The overarching challenge and goal is to prepare for the next earthquake, by learning from the current crisis. Nepal rests on a major fault line with increased seismic activity.\textsuperscript{15} With major earthquakes ranging from 7.8-10 magnitudes reported in 1833, 1934 and now 2015, Nepal is on a cycle of major earthquakes every 80-100 yrs.\textsuperscript{16} To prevent a reoccurrence in the staggering numbers of deaths and displaced persons, a valiant effort will need to be made to ensure the proper reconstruction of buildings damaged during the 2015 earthquakes and any subsequent newly constructed buildings in the future.


The rebuilding of permanent buildings in Nepal will require an enormous collaborative effort that faces many challenges and a long time line. This thesis aims to articulate influencing factors to the overarching challenge and identify the intertwined connections between them. In the midst of this long timeline, this thesis focuses on creating solutions towards the immediate need of “transitional housing” for the many still living in emergency shelters.

The International Medical Corps recorded shelter as the number one stressor related to basic needs, above physical needs, hygiene, food and nutrition, and clothing and blankets. The remaining discussion will focus on the transition from emergency housing (see figure 10), defined as tent or makeshift tarp dwellings, to temporary housing (see figure 11), defined as dwellings constructed from bamboo and salvaged materials that utilize corrugated tin sheets as roof covering. This thesis formulates solutions to the temporary housing transition while considering the identified contributing factors to the overall effort to rebuild permanent housing in Nepal. The solutions seek to provide residents with a suitable “transitional” shelter (long-term temporary shelters) as they consider how they will need to rebuild their permanent homes.

Figure 10. Emergency shelter example

Figure 11. Temporary shelter example
2.3.1 Maintaining Architectural Vernacular

To be most effective, the solution must consider the architecture vernacular that is associated with each regional area. The whole point of making safe buildings is to protect the lives of the residents, but one cannot complete this task without considering their cultural heritage and the surroundings that they are accustomed to. In Bungamati, I interviewed local residents who were put off by the sleek modern shelters provided by Danish aid organizations. These very efficient, safe and well constructed shelters served every purpose in providing shelter, but overlooked the importance of local vernacular, therefore alienating the villagers in Bungamati. The challenge here becomes creating designs with affordable and safe structures while maintaining the local architectural aesthetics.

Figure 12. Danish shelter example
2.3.2 Shelters They Have and Problems They Face

The Nepali government distributed half barrel shaped shelters constructed from steel ribs and enclosed with corrugated tin sheets that are continuous from ground to ground along the arch of the barrel. To secure life and property, individuals must enclose the two ends of the barrel in some manner. Once the shelter is enclosed it becomes like an oven in the hot Nepali sun, and when the monsoon rains arrive it is deafening inside the shelter. In many locations I found these shelters empty or used as storage for property rather than shelter for people.

Figure 13. Empty half barrel shelters distributed by the government, used for storage.

Alternatively, another common shelter type was constructed from bamboo and salvage materials and used tarps for wall and roof surfaces. The longevity of these shelters is dependent on the quality of tarp. Usually these tarps were cheap, dry rotted,
or punctured leaving users with a shelter that could not be counted as temporary housing.

![Emergency shelter constructed with salvaged materials and tarp walls and roof.](image)

Figure 14. Emergency shelter constructed with salvaged materials and tarp walls and roof.

The predominant shelter type was constructed from bamboo and corrugated tin. When constructed properly, they can last the life of the untreated bamboo (3-5 years) and perhaps even longer if bamboo is maintained or replaced at localized failure points, both of which should be acceptable for a temporary home. Wrapping and twisting steel-bandaging wire is commonly used for connection of bamboo members in this construction typology. These connections are a likely point of failure when the wire is twisted too tight. Alternately, they become loose and ineffective when the structure shifts.
2.3.3 Transition to Permanency

The notion of temporary housing was perhaps the most unsettling issue that arose during interviews. Many of the temporary homes were built as quickly as possible and signs of improper workmanship were abundant. Some relief aid attitudes that I encountered were that people needed to rebuild their permanent homes; they needed to take responsibility and be part of the rebuilding effort. While I agree wholeheartedly with the idea of the people’s involvement, I think that the reality of “temporary” is quite a bit longer than is currently being considered. With no system of insurance, lack of skilled labor, poor economy, and low wages, those who lost their homes lost everything they had and it will take many years to save the money necessary to rebuild properly. Applying pressure to the lay person to rebuild their permanent home, through poorly considered “temporary housing”, will only aggravate the problem and encourage a continuation of poor construction and unsafe homes.

Figure 15. Predominant shelter type constructed with bamboo and corrugated tin.
2.3.4 Financial Reality

An obvious major challenge is funding, particularly in these remote villages where extreme poverty exists. Poverty in these areas means these villagers have virtually no working income. They may own a small piece of property, perhaps passed down in their family, and work during planting and harvesting season as sharecroppers. With limited resources and means, and inadequate government response, villagers have little to fall back on. The villagers know that the temporary houses they have will only last so long, but the lack of financial means and foreign aid is forcing their hand in rebuilding stack stone homes. Most villagers are currently clearing out their collapsed home sites with plans to use those materials (clay and stone) in the same construction methods for rebuilding. Why? Two reasons: it’s all they have and it’s all they know. If executed correctly, proper stone construction can certainly provide nice homes, the problem is that this process requires numerous other materials to be carried out effectively and is an expensive building technique. The financial situation in Nepal is further hindered or dependent on the following:

- Remittances- Money that Nepali’s working abroad send home accounts for 25% of gross domestic product/income.18
- Remuneration- Paperwork to receive support from the government for lost property is very difficult to complete and keeps many from even

applying. Standard compensation for loss of home is 15,000 rupees ($150 US); estimated basic home construction is 60,000 rupees ($600 US).\textsuperscript{19}

- Distrust in a Corrupt Government- A long history of corruption hindered effective and fair distribution of any relief aid mechanisms. Reports that the government commandeered relief aid, to be distributed first to military and government families, only propagated this fear.

- Tourism- One of the largest contributors to the economy has almost vanished from the country since the earthquake.

2.3.5 Aid Distribution

It was common knowledge for Nepalis that the aid distribution was poorly handled in the immediate aftermath of the earthquake. In addition to government and military corruptions, a lack of organization had some areas over saturated with aid while others received nothing. Villagers in areas with over saturation commented, “The earthquake is the best thing that has ever happened to us, look at all the stuff we have received.” Many villagers took advantage of the poorly organized aid distribution returning again and again to stock up on supplies.

In terms of emergency shelter and temporary shelter, rural and remote locations struggled to get anything. It is difficult to transport large quantities of tents and any prefabricated temporary structures were impossible to get to these locations. In the

midst of such horrendous destruction, and with a complete lack of any organization in foreign aid distribution, an aid group would have to pass up many opportunities to help in order to reach these other remote locations. Such an approach was highly unlikely. The only reason these remote areas would receive any aid was through family members living in Kathmandu lobbying for their home villages.

2.3.6 Entrenched Knowledge

Breaking the cycle of poor construction pivots on two major factors: accountability in construction through the enforcement of building codes through inspections and, and overcoming the history of how building has transpired for centuries in Nepal. The skilled labor that is available has been trained and brought up under a system of little to no accountability. Through this system, those who are supposed to be the professionals commonly accept dangerous practices in cutting corners and constructing un-engineered structures. It is not difficult to imagine what this means for buildings that are now being constructed by individuals who have no experience in construction and are only influenced by what’s around them.

2.3.7 Insufficient Skilled Labor

The lack of education and skilled labor in Nepal creates a huge hurdle for rebuilding earthquake resistant structures. Often individuals constructing residential buildings have no formal training and perhaps little general education and no life experience beyond their village. Freelance journalist, Allen Gula is currently based in
Kathmandu and researching long-term earthquake relief programs. He writes the following. “But who will rebuild all the houses? This question keeps planners up at night, while those whom they’re planning for are asleep under tarps, makeshift shelters ... I think the answer is that while resources and support will be available to international donor, socially acceptable districts- the vast majority of rural home reconstruction will be carried out by individuals themselves. The universe has thrown a learning curve to the most versatile demographic in Nepal, self made farmers are going to have to rebuild their own homes to the extent and capacity with which they are able to, with or without support from the government or anyone else.”

Despite the lack of skilled construction labor, there is a large number of textile, wood and metal “craftsmen”. It is my experience that these individuals know one skill very well and often lack the confidence or belief that they can do more. Effective solutions to housing might be hindered by limited construction labor but has the potential to capitalize on these craftsmen. However, the development of a successful housing project must assume that those constructing it will have little to no experience in construction. To be effective and to preserve life, the solution must be extremely simple to use and understand with a small margin for error in critical structural elements of the design.

2.3.8 Poor Quality of Tools

Insufficient skilled labor is compounded the lack of quality tools for typical construction techniques. Particularly in the rural villages, the dull, low-quality and limited tool set available only adds frustration to the other factors discussed in this section. A frustrated and tired worker, especially one who doesn’t understand the importance of decisions made during construction, is more likely to take a short cut that results in poor craftsmanship.

Figure 16. Collection of all the available tools at the Kaski permanent housing site

2.3.9 Material Knowledge: Flawed Conclusions

2.3.9.1 Primary Materials: Constructive

When faced with deciding what to build with, basic conclusions to material choices are often incomplete or flawed. For instance, the perception that stone is
stronger than wood therefore it is a better building material. This might be true if the constructive technique being used is appropriate. For example, is the stone put together with clay or cement? Furthermore, the conclusion that load bearing masonry walls, even those constructed with cement, are dangerous in this region has been common construction knowledge for decades. This knowledge however doesn’t permeate the most remote locations of our globe.

2.3.9.2 Secondary Materials: Connective

The connective material choice was observed as a secondary consideration, particularly in masonry construction, and was also the first place that corners were cut. Large stones were often used to fill the volume of foundations that were formed with little concrete and without vibration techniques to settle to concrete and fill the gaps. In the temporary structures built with bamboo, steel-banding wire was the material of choice for lashing bamboo together. While metal is stronger than rope, natural fibers, or bamboo, it was very difficult to sufficiently tighten with a limited toolset. When it could be tightened, it was often twisted to the point of failure. Additionally, poor techniques in how the connection was actually wrapped left an illusion that the connection was tight, but as soon as something shifted the wire was loosened dramatically.
Figure 17. Large stones used to fill the porch footers.

Figure 18. Poor techniques in bamboo connections using the steel banding wire.
2.3.10 Transportation and Availability

Road systems in Nepal are very limited and in disrepair even in the most populated areas. In rural regions, roads are often non-existent and many villages are only accessible by footpaths. Additionally, material availability in Nepal is limited and depends largely on imported goods; availability is increasingly limited as you move away from urban regions of the country. The supply and demand ratio, coupled with limited transportation, drives the cost of supplies upward as distance from the source increases.

2.3.11 Difficult Working Conditions

The hot and humid climate, combined with a lack of money is a large contributor to poor construction. The general attitude in construction is “it’s fine the way it is” or “screw it we have no other choice”. This attitude reflects the physical exhaustion of working in a harsh climate, and identifies that reducing physical exertion can potentially improve workmanship. To address physical conditions a successful design will assist workers, eliminate unnecessary hardships, and shorten the construction process. Conserving energy exertion from those working in unfavorable conditions has the potential to improve a worker’s overall demeanor towards the quality of construction.

2.3.12 Cutting Corners and Improper Workmanship

Many of the above factors contribute towards an attitude that places little value on proper construction techniques or quality workmanship. In the development of solutions, one must consider how the process can be simplified while at the same time providing education about proper construction techniques and their value.
method that is simple, fast, and repeatable, eliminates room for human error, and is accompanied by an educational and instructional value system, can improve, workmanship.

2.3.13 Social, Cultural, and Psychological Factors

Two underlying attitudes, deeply rooted in the country’s history of hardship, lack of economic industries, and foreign relief aid dependency, were prevalent during field research.

1. “Yo Nepal Ho” and “Ke Garne”: “This is Nepal” and “What to do”: Common flippant remarks made by Nepali villagers that express resignation with the given situation undermine progress towards effective changes. These attitudes both accept current hardships and dismiss the possibility of a better tomorrow.

2. Handout Mentality: People are often reluctant to work because there is an expectation that foreign aid entities, are coming to do it for them. This mentality fosters an attitude of entitlement amongst communities accustomed to receiving aid.

Anthropologist and professor Dr. Stacey Pigg studies tradition and modernity beliefs in Nepal. She describes her work in this area by stating, “I am concerned specifically with the vision of identity and difference embedded in the narrative of modernization. This narrative posits a rupture, a break that separates a state of modernity from a past that is characterized as traditional.” Embedded traditions drive
the skepticism that change, advancement or hope will ever exist in Nepal. Pigg writes, “From the point of view of this small, marginal, and impoverished country, modernity is somewhere else-India, perhaps, or China. The question, for many, is how to bring modernity here, and whether it is possible to be "here" in Nepal and be "modern."”

2.3.14 Disaster Preparedness

People are receptive to efforts to teach and plan for future disaster. The receptive mentality is founded on indigenous religious stories, which state, “God helps those who help themselves.” Involving locals in the rebuilding process not only aids in teaching ownership but can potentially save lives by reinforcing responsibility for preparedness.

2.3.15 Urban vs. Rural Attitudes/ Cohesiveness

Studies found greater community cohesiveness and willingness to work in rural areas where little to no relief aid was received. When faced with the reality that they were on their own, these communities united and helped one another to rebuild.

Researchers involved in Learning From Earthquake Reports, conducted by the


Earthquake Engineering Research Institute clearly identified this as community resilience and stated, “If people are properly equipped they can rebuild themselves.”

2.4 Problem Statement:

Progress moves slowly inside the broken and dysfunctional regulatory agencies that both govern and institute change in Nepal. In the aftermath of the earthquake, the people of Nepal are struggling to sustain basic humanitarian needs and safe affordable temporary housing. Compounded by a diminished skilled labor force the task and responsibility of rebuilding is placed on the individuals who lost their homes. Effective initiatives can address these challenges by considering how to utilize locally available materials, educate and empower the unskilled population, rely on local community resiliency, and build on existing indigenous skill sets and knowledge.

CHAPTER 3:

IDEATION:

“The process of generating, developing, and testing ideas.” 24

-Tim Brown

3.1 Design Directives

The ideation phase refers to the findings detailed in field research to indentify an area for intervention within a given problem space. The core objectives seek to develop possible solutions to the challenges that hinder the transition from emergency shelters to the construction of temporary housing. In the rural and remote locations encompassed in this study, the limited availability of materials, lack of skilled labor, and narrow scope of building typology created hurdles for individuals needing to begin the processes of building temporary housing. The ideas in this section seek to meet the evident need for establishing methodology in the layout, leveling and location of structural elements for post and lintel construction. Bamboo, an appropriate material

for post and lintel construction, is a readily available and renewable resource in rural Nepal. Field research demonstrated that basic knowledge of bamboo connections and significant knowledge of bamboo crafts were present and could be leveraged in the construction of temporary housing. The following design directives were laid out to ensure that rigorous and informed design solutions would be reached.

3.1.1 Balance Vernacular and Structure

Nepali villagers want to have a strong structure, but they also want to have a home. They want a home they can take pride in, one that represents the heritage and culture they know, and one they can make their own.

3.1.2 Modular/ Phased Approach

Building in Nepal is tough and faced with physical, environmental and financial challenges. A modular and/or phased approach to construction will assist in addressing these difficulties by simplifying and segregating construction processes.

3.1.3 Visual Learning

As learned in field research, a physical demonstration breaks through the difficulties faced in verbal communication of new ideas and techniques. Using physical examples, tools, or systems, is the most effective method to ensure adaption of new temporary housing construction methods and concepts.
3.1.4 Rapid Learning Systems

Entrenched knowledge and limited exposure to construction typologies create barriers to new construction methodology. In order for uptake of a new method, tool, or technology, solutions must be easily understood and quickly demonstrate their usefulness.

3.1.5 Capitalizing on Handicraft Traditions

Although the number of skilled construction laborers is limited, the tradition of handicrafts in Nepal is virtually ubiquitous. These crafts, particularly bamboo and textile techniques, can be utilized in the wall surfacing of temporary shelters. Not only does this utilize a wealth of existing knowledge, it also encourages personalization of homes and pride of participation/ownership in temporary housing construction.

3.1.6 Human Factors

In addition to educating an unskilled construction force, human factors of shelter design must consider that the Nepalis who are healthy and skilled will return to work to provide for their families and villages. Those left to rebuild will likely be the women, children, elderly, and sick. Effective design solutions must consider ease of construction in terms of weight, height, and assistance.²⁵

3.1.7 Inclusion or Omission of Tools

An appropriate solution will consider the poor quality and limited availability of tools in Nepal. The solution to the construction of temporary shelters will be most efficient when it completely eliminates the need for tools or includes the necessary tools for assembly.

3.1.8 Lightweight or Local Materials

With the difficulty and cost of transporting materials in Nepal, the design solution needs to utilize local and/or lightweight materials. There is an abundance of salvage materials from the collapsed buildings. This includes door and window components, wood for framing, and materials for sheathing. Additionally, bamboo is an abundant and renewable resource in Nepal and should be utilized to construct temporary housing. Portability must also be considered when designing equipment, tools or shelter solutions for building temporary shelters. Often, roads are inaccessible or non-existent requiring individuals to carry any necessary components over rough and often narrow terrain.

3.1.9 Connective Materials

The flawed perceptions that connective materials are less important than constructive materials can result in unstable and poorly constructed shelters. Solutions must consider how to ensure that proper connection techniques and materials are used during construction.
3.2 Methodology:

3.2.1 Casting a Wide Net

Initial efforts in developing a design direction focused on the totality of factors that must be overcome for Nepal to recover from the earthquakes of 2015. The data collected from field research was first categorized into logical “buckets” which included categories such as finances, transportation, education, etc... These “buckets” were conceived in a linear process of thinking and contained multiple points of factual data as well as comments from interviews conducted during field research. Collecting and organizing this data is only the first step, stopping here is often a trap that leads to repeating or reimagining existing solutions, instead of creating new solutions.26

Figure 19. Data collection board organized into logical “buckets”

Applying designing thinking methodology to this logic model, I sought to identify the “why” behind the categories and looked for connections between them. This process began to identify how these different categories influenced one another and a new “organization” of the data was laid out in a non-linear mind map. Data synthesis helped to reorganize the information in a way that demonstrated the totality of the challenges faced in rebuilding and the relationship of one challenge to another. From this I developed the design directives, insights, and areas for design intervention.

![Figure 20. Final mind map reorganizing the data and identifying connections and insights](image)

3.2.2 Under the Microscope

Taking insights from the data synthesis processes, as outlined in the section titled *Design Directions*, I went through a process of considering each individually. For example, how could I address the undervalued importance of secondary materials (connective materials) in a design solution? Or how could I design a building methodology that utilized local traditions in handicrafts?
3.3 Approach 1- Pre-Fab Shelter

The first concept investigated efficacy of prefabricated shelters. This idea seemed like low hanging fruit and perhaps somewhat of a trap along the path to innovation. Nevertheless, experience has shown that sometimes designers just need to get the bad ideas out on paper to make way for better ones. The idea of a prefabricated shelter came from several insights, mainly the potential for a modular design to be effective in overcoming some challenges in transportation and limited finances, and the need to provide solutions that included tools or omitted the need for tools (RTA furniture as epitomized by IKEA as an example). Ultimately, this approach wasn’t pursued due to a vast number of existing concepts for disaster relief shelters that have remained just that, a concept.

3.4 Approach 2- Tool Set

The poor quality or lack of tools encountered during field research made consideration of this limitation a must. Providing a tool set will potentially be met with immense challenges and choices to consider, including foreign or domestic manufacturing, appropriate cost, distribution, and effectiveness. It seems more appropriate that this issue be addressed through grant funding to purchase or distribute tools, or initiatives to increase tool manufacturing in Nepal. The bottom line is that good tools exist and I’m not confident that designing another set will truly resolve any issues. However, sourcing tools to include in a sheltering solution is worth considering in further stages of implementation and refinement.
3.5 Approach 3- Bamboo Connectors

Considerable consideration was given towards creating a bamboo connector that would simplify and improve the quality of the construction process. This concept focused on design directives in the areas of Visual Learning, Rapid Learning Systems, Inclusion or Omission of Tools, and Connective Materials. Bamboo connectors demonstrated feasibility for visually and rapidly instructing unskilled persons in the construction of shelters. The connector itself would resolve issues between connective materials, improve structure and workmanship, and eliminate the need for tools, with the exception of cutting the bamboo to desired lengths. Additionally, the connector concepts considered how to increase speed and efficiency, utilize the bamboo nodes, and address construction challenges brought on by the variable diameter of bamboo. Connectors were also considered in conjunction with the shelter template outlined in the next section. It was ultimately determined that a building system founded on a connector only lasts until you run out of connectors which would limit the success of this initiative, particularly in rural and remote locations.

Figure 21. Bamboo connector prototyping exploration
3.6 Approach 4- Shelter Template

The concept here was to create a mold, jig, or template that bamboo structures could be built around. This focused on a holistic inclusion of all design directives. The shelter template conceived a series of x-shaped panels joined together to form a cube.

To create a lightweight and portable system the process imagined the construction of one quarter of the building frame at a time. Additionally, building with shorter sections of bamboo limits the change in diameter across the length of each structural member and creates more standardized parts. Once the template is erected, bamboo poles are inserted into the positions located on the template and then connections of the bamboo can be made while supported by the template. The layout for a square and level structural frame is provided in the design of the template. Layout techniques typically require a trained professional to be executed properly whereas the shelter template makes structural layout simple for anyone. When the template is erected it creates a perfect cube. The cube can then be leveled with adjustable feet on the floor panel. In the initial concept the template could be moved around the site through a process of folding and unfolding the template panels. Moving the floor panel last keeps the template square in plan view. Once the building frame is constructed and the connections are secured, the template can be used for the next structure.
The shelter template demonstrated the most feasibility in empowering an unskilled labor force to build their homes. While the quality of tools is an issue, cutting tools are readily available while skilled labor to direct construction is not. The concept requires only a tool for cutting bamboo, which is relatively easy when compared to cutting other indigenous woods available in Nepal. Furthermore, this approach breaks away from the traditional handout of prefabricated or volunteer built shelters. Actively involving villagers in the building process instills a sense of responsibility and hope for change. Some training may be necessary to get the initiative started, but once
demonstrated the process should be easily repeated. The flexibility built into the concept allows the homeowner to make design decisions that determine roof style, floor plan, window and door location, and building finishes. This encourages a sense of individuality and pride in home ownership. The cost of manufacturing one template might reach the cost of one prefabricated shelter. The difference is that from one template hundreds of shelters can be built utilizing locally available materials. Factoring in the cost of distribution of numerous shelters versus the distribution of one template, further justifies this approach. Furthermore, there are many locations to which transporting a prefabricated shelter is impossible. The argument here bolsters the case for a solution utilizing a template over a ready-made solution.
CHAPTER 4:

IMPLEMENTATION:

“The path that leads from the project room to the market.”  

-Tim Brown

4.1 Final Direction:

4.1.1 Prototyping

A rigorous effort was given in the prototyping, testing and refining of the concept. Faced with extreme challenges in terrain and accessibility, the prototyping phase of the project continually pushed for a “less is more” approach. Throughout the prototyping phase the process constantly shifted back and forth in scale and accuracy of material. The concept was tested first as desktop models executed in paper, then in full-scale cardboard mockups, and finally as scaled models in accurate materials.

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Figure 23. Full-scale cardboard mock up of original template concept

Figure 24. ¾ scale vacuum formed prototype of original template concept
Virtual prototyping was also utilized through CAD modeling to investigate numerous forms and manufacturing techniques. These techniques included extrusion, rotational molding, injection molding, and vacuum forming to determine the most affordable, lightest, and strongest solution.
The concept began as a system of x-shaped panels that would be folded and nest together for portability. The physical prototyping showed that most of the desired function and strength took place in the corner. Recognizing the functional and structural importance of the corner caused a transition from panels to a series of corner and x-shaped connectors that could be assembled into the desired template form. These components can then be disassembled and stacked together which shrinks the volume and weight of the template to nearly one third of the original concept. The new direction also eliminates the need for complicated mechanical parts, which greatly reduces potential points of failure.

Figure 27. First prototype of new direction
Figure 28. Half scale vacuum formed corner prototype with bamboo locations molded in.

Figure 29. Quarter scale prototype stacked to test nesting and portability concept
4.1.2 Solution Description and Visualizations

The final solution is a system that takes the place of a carpenter or foreman and makes constructing a temporary shelter safe, simple, and repeatable. Following the old philosophy, “Give a man a fish and he eats for a day; Teach a man to fish and he eats for a lifetime”, this initiative set out to design a system that would empower people to build their own shelters.

From this endeavor, PACK: Rapid Shelter System has been created. Once disaster strikes these portable systems can be carried in to the most remote of locations. On site the system is unpacked from its case, the case is unfolded to reveal a detailed instruction set for the assembly of PACK, and the construction of the shelter. Assembled, PACK acts as a system for layout, leveling, and location of the bamboo structure. As the bamboo is cut and secured to the building template, the system assists by supporting the bamboo during the construction process.
Figure 30. PACK nested and wrapped in carrying case

Figure 31. Instruction mock up
Figure 32. PACK assembled

The geometry of the corner connecters is designed to keep the bamboo stabilized by the PACK template, while leaving space in the areas needed for digging post holes and connecting bamboo to bamboo. The system functions by building a quarter of the structure at a time. Once the first quarter is built, PACK is released from the structure by deploying the corners inward, which effectively disengages the template from the structure. The template can then be lifted and moved to the next quadrant of the structure.
Figure 33. PACK moved from one quadrant of the structure to the next building one quarter at a time.

Figure 34. Corner deployment and securing the bamboo to the template
Careful consideration was given towards providing flexibility in the final form and aesthetics of the shelter. While the intention is to lead individuals through the process of creating a square shelter, the template acts as a freestanding module that can be arranged to form various floor plans such as rectangular and L-shaped layouts. The wall frame division apparatus can be attached to any side of the template during construction and allows for the inclusion of windows and doors as desired. Additional instructions are provided for multiple roof framing styles such as hip, shed, and gable roof configurations.

Figure 35. Door and window wall division

Figure 36. Shed, gable, and hip roof frame examples
Perhaps the greatest flexibility is given in the finishing of wall and roof surfaces. Suggestions and examples are provided in the instruction set, however this is an area that the Nepali people excel at. To name a few, walls can be finished through a combination of bamboo and plaster, salvaged materials, and decorative woven bamboo mats.

Figure 37. Wall surface finishing examples

Figure 38. Quarter scale prototype of PACK with bamboo structure
After completion of design visualizations and model making, the spring of 2016 was spent bringing this concept to life. The images below show a full-scale looks-like and works-like prototype of PACK: Rapid Shelter System.

Figure 39. Full-scale prototype in the Snite Museum at the University of Notre Dame
Figure 40. Full-scale prototype in the Snite Museum at the University of Notre Dame

Figure 41. Backpack prototype in the Snite Museum at the University of Notre Dame
CHAPTER 5:
CONCLUSION

If “abstract thinking”, according to Capra, lead us to “a fragmented view of our human society, dividing it up into nations, races, religions and political groups” and results in “alienating us from nature and from our fellow human beings.” Then perhaps design thinking will be the avenue by which we “regain our full humanity.”

This thesis, and the subsequent design, is founded on a belief in the power of design to make a positive impact on our world. Design is greatly under utilized in our world and far too often it only permeates the developed world. To make a difference in humanity, one that is all-inclusive, perhaps we should leverage an approach that is “inherent within human cognition” and is “a key part of what makes us human.”


The above paragraph is my reflection on the hard work of others. The following is how this thesis and design objectives contribute to the growing body of knowledge. The most substantial contribution is demonstrated in the holistic and open-minded immersion methods used for research, and the rigorous iteration applied towards developing the design solution. My first hand immersion in Nepal allowed me to place value on understanding all the stakeholder perspectives and influencing factors, which in turn, drove innovation. To understand the real issues in such a wicked problem takes a great deal of empathy towards those truly effected by it. One can be empathetic from a distance, but when you are there, when you experience the reality, hardships, and most importantly the emotions and passions of the people, empathy will increase. Experiencing that change drove a human centered design process that focused on providing effective solutions for the people of Nepal. The most critical step in the design process was the first one, identifying the underlying factors to the problems. Early on it’s tempting to make assumptions and cling to obvious directions, however, digging deeper and working to understand the interconnectivities among complex factors produces richer outcomes with greater possibilities for success. Desire to achieve an appropriate solution is demonstrated through a design process that produces a volume of initial ideas and a constant refinement toward a chosen direction. It is through iteration, dissatisfaction, and hard work that designs become successful.

The MFA thesis exhibition in the Snite Museum at the University of Notre Dame drives an early resolution of this project. While appearing polished, this is actually step
one in developing a fully functional solution. This initiative anticipates further on-site testing using the prototype developed for the exhibition. The efficacy of PACK will be evaluated in Nepal at the locations discussed in this thesis to direct the next steps in design refinement. The efforts of this research hope to reach beyond Nepal and its current problems with sheltering and into the development and influence of future design initiatives by others addressing similar challenges.


