Disaster Relief and Reuse

Beth R. Valenta
University of Nebraska-Lincoln, be_vale@hotmail.com

Follow this and additional works at: https://digitalcommons.unl.edu/archthesis


This Article is brought to you for free and open access by the Architecture Program at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Theses from the Architecture Program by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.
“each of us as human beings has a **responsibility** to reach out to help our brothers and sisters affected by disasters, one day it may be us or our loved ones needing **someone** to reach out and help.”
“this is the real news of our century. it is highly feasible to take care of all of humanity at a higher standard of living than anybody has ever experienced or dreamt of”

r. buckminster fuller
problem: community ravaged by earthquake disaster

intent: design a flexible, long term plan for disaster relief. This would be done by designing and building an earthquake resistant structure to hold temporary housing and emergency support, which over time, would convert to a community resource center.

project intent: disaster relief and reuse
the human state in the aftermath of a crisis is at its most vulnerable.

the goal of disaster relief is to evaluate the needs of a community and options available for creating shelters for displaced persons in the aftermath of a natural disaster.

after a disaster, more than at any other time, people are concerned about their safety and security. architecture has the ability to provide a level of comfort through dwellings, which provide shelter, privacy and security. once safety and stability are established, a healing process can begin.

architecture has two basic solutions for disaster relief. the first is to set up a temporary site and structure designed for efficient construction and deconstruction. the second response is to create a more permanent solution. in either response, a structure should minimally impact the area on which it exists, and designs should nurture growth of the site and surrounding context rather than destroy it.

currently, in many cases there is a disconnect between temporarily established shelters and the construction of more permanent dwellings. research will explore the existing building methods from the more temporary shelters to the more permanent, in an attempt to bridge the gap between the two. an analysis of this research will provide insight to building needs and minimums along with a comprehensive understanding of how materials and services are obtained. research will explore new and improved methods for constructing and implementing them into these shelters. case studies will examine many different building types and how each solution solved specific problems. the disasters themselves will also be explored, along with how their devastation affects the local landscape.

this terminal project will focus on how to better integrate a set of permanent and site specific dwellings and community resource spaces into a ravaged community.

the goal of this disaster relief project is to design a community resource center and shelter that will act as a sustainable intervention for people affected by a natural disaster as they struggle to rebuild their lives.

the designed product will be a series of permanent structures built on a site recently devasted by natural disaster. the basic program comes from a set of minimums required for the center. each community center will need a certain number of square feet, a set number of classrooms, offices and living space. minimal changes would be made to these plans based on location of the site and a response to local building traditions and local building resources. the goal is to create a standardized checklist that is molded to respond to site-specific building materials and local building skill set.
to produce a more permanent structure, every type of building system will need to be researched, from the structural characteristics of each of the materials used to the plumbing and electrical systems, if applicable. included in this research would be the exploration of sustainable characteristics of these building systems and building materials. local resources and material availability would play a role in determining structural components and building details.

this will not be a “one size fits most” community program that is shipped to each site. the objective is to establish a list of criteria for a buildings needs, and square footage minimums. this criteria would also assess the availability of materials and a skilled labor force. each individual site, given its climatic location and cultural traditions would generate different responses to this list of criteria.

the success of disaster relief is to make it adaptable for a variety of physical site conditions. to explore these varieties, three sites would be chosen to study based earthquake devastation. sites will range from every inhabitable continent on the globe, with diverse cultures, climates, income levels, and social structures. the sites will be located in developing communities who are struggling to recover from a devastating earthquake. a possible site locations include such countries as: sri lanka, the philippians, pakistan, turkey, guatemala, indonesia, the dominican republic, and the andeanof islands in alaska.

as an example; guatemala, turkey and indonesia have very different cultural traditions, social structures, and building styles, yet they all suffer from ravaging earthquakes. an analysis of these three locations would discover that each would have a different built response to the earthquake. for example, construction in guatemala typically uses timber studded walls covered in stucco or painted plywood board, which are set on a foundation of filled concrete block. in some locations, wood is more readily available and would be used as roof and window coverings. alternatively, in sri lanka, homes in rural villages are typically dry-stacked earth blocks resting on a stone foundation. newer, more earthquake resistant construction is built out of hollow concrete block with reinforced steel rods. turkey on the other hand, being a more developed nation with an arid environment, low rise structures are typically built from timber reinforced stone walls covered in stucco, with wooded details and tiled roofs.
"everybody wants the same thing, rich or poor, not only a warm, dry roof but a shelter for the soul"

samuel mockbee
paper church
transitional community
pre-fabricated wall
pre-fabricated core
core house
safe[r] house
resilient wood frame
straw bale
light-weight solution
shake resistant
super adobe
hopi nation
quinta monroy
bamboo frame
young apostles international
raramuri school
maasai integrated shelter
white orchard
homeless legacy center
telemedicine center
rebuild haiti
community core
soundhanikuppam
1024: youth center
habitat initiative
pillai chavady kuppam
ambedker nager
yodakandiya
the paper church, was a temporary spaced designed by japanese architect, shigeru ban, which was constructed in response to a devastating earthquake that struck kobe japan in 1995. the community space was built by church volunteers who's worship hall was destroyed. erected in only five weeks, the church was built from a skin of corrugated, polycarbonate sheeting and 58 paper tubes measuring 325 millimeters in diameter and were 5 meters tall. the paper tubes were arranged in an elliptical design while the polycarbonate sheets remained rectangular. the space formed between the ellipse of the tubes and the square sheets provided the building with lateral support. the church was disassembled in june, 2005, and all the materials were sent to taiwan to be recycled and reused.
built as a response to the 2004 Indian Ocean tsunami that struck Sri Lanka, these transitional shelters worked to provide families with shelter and reusable building materials. Located in Tangalle, Sri Lanka, the shelters were erected in a city park using a mixture of timber studs, plywood sheets, corrugated roof sheeting, and cement block. A goal for the project was to use materials that once the transitional shelter is disassembled, could be reused in the construction of a family’s permanent residence. The total cost of the project was $580 [us].

“these are ‘transitional’ as opposed to ‘temporary.’ Emergency shelter is temporary and is intended just to provide shelter for survival. Transitional implies something that is longer-term and gives you space to carry out livelihood activities rather than just surviving.”

Elizabeth Babister
relief international has set up education and training programs in communities for displaced persons living in azerbaijan. some of these programs are designed to teach and train individuals to construct homes and schools within their community. these buildings are constructed out of plaster covered CMU walls with timber framing, and are enclosed by a corrugated metal roof. the housing projects constructed are 258 square foot structures, built at a cost of $2,100 [us].

due to the earthquake that devastated much of chile in february 2010, many families were in desperate need of shelter. habitat for humanity designed plans for a low-cost, pre-fabricated home. these homes consisted of an earthquake resistant structural core which was then erected on a solid foundation. the wall system was designed specifically for the climate in chile.
Habitat for Humanity responded to the numerous earthquakes which struck Indonesia in 2010 by designing an earthquake resilient core house. These 18 square meter homes provided simple shelter and could be expanded upon by using salvaged materials. These homes were constructed through ‘sweat equity’ meaning everyone helped everyone build their home and rebuild the community. As part of a co-op this allowed each family to work off the payment for their core house.

As a response to the 2004 Indian Ocean tsunami and the devastation wrought upon Sri Lanka, a team of college graduates and design professionals developed a model for a dwelling that would resist the forces of a tsunami along with the flood waters. The design of the structure emphasizes the use of locally available building materials and building methods. The safe[r] house has a four part C-shaped design built from concrete block, tiled roof, and bamboo slating. Each unit is 200 square feet and cost around $1,500 [us].
after China’s earthquake in 2008, devastating many of the nation’s poorest providences, Habitat for Humanity designed an earthquake resistant home that would not only meet the government’s guidelines for earthquake construction, but could also be build at a low cost to the homeowner. These residences are constructed from a wood frame, with walls consisting of red brick, stone, straw, compressed earth blocks and/or fiber board.

After the January 2010 earthquake that crippled much of Haiti, Builders Without Borders lend a hand to help start the rebuilding process. Builders, along with the help of the homeowner, erected culturally appropriate-earthquake resilient structures constructed from simple materials. Each unit rested on a concrete slab, and a timber frame helped support the bales of straw used to insulate the home. Straw is a locally grown material and stand up very well to the tests of earthquake forces.
in response to seismic activity in pakistan, architecture for humanity designed a lightweight, seismically resilient house to help rebuild many of the mountain communities. these dwellings are constructed using local building techniques which use simple timber reinforcing that rests on a lightweight concrete footing. the walls are infilled with stone and mud bricks. each dwelling has a 72 square meter footprint.

habitat for humanity designed an extremely earthquake resistant housing unit for low income families in costa rica. each house is constructed using a steel post and beam structure which is tied to a reinforced slab on grade; walls are covered with steel mesh and infilled with gravel, then covered with plaster. the 60 square meter dwelling costs $600 [us] to construct.
Iranian-American architect, Nader Khalili, first designed the Super Adobe construction system in response to NASA’s challenge to design housing for future human settlements on the moon. The technologies and systems he developed were then applied to emergency shelter projects to provide a safe harbor for Iraqi refugees seeking shelter in Khuzestan, Iran. Polypropylene tubes are filled with sand or dirt and are then laid in a dome form. The tubes are tied together using barbed wire, and once the domes are finished they are stabilized with lime dust and earth plaster. A typical dwelling is 150 square feet and costs $625 [US] to construct. To help extend the life of an Adobe structure, in many cases, Khalili applies a ceramic process to the dwellings, in which all the doors and windows are removed and the building is sealed and set on fire. After a structure has burnt for three or four days it has turned into brick and will withstand the rain and snow better.
Nathaniel Corium designed an elderly home for the struggling and homeless, native American population in the USA. This single family and assisted living center was constructed in Arizona, USA, out of strawbale and timber trusses. The building is energy efficient and was built at a low cost to the community. The small, efficient building footprint allows for a flexible floor plan to meet the residence’s ever-changing needs.

Quinta Monroy is a government provided housing project designed for impoverished persons living in Iquique, Chile. The project houses 100 residential units, designed as small, efficient spaces. The 72 square meter units are constructed from concrete and cement bricks.
to help rebuild Haiti after a crippling January 2010 earthquake, Architecture for Humanity responded to a school initiative project to design new, earthquake-resistant school structures. The schools were constructed using a strong, bamboo frame, insulated with adobe bricks and finished with plaster. The use of local materials and labor force stimulated the local economy, and allowed the schools to become a community-centered space.

Young Apostles International is a school and community space in Kumasi, Ghana. The center can serve up to 150 people daily between its ten classrooms and eight meeting rooms. Also located on the site are ten staff and teacher offices, a library, large gathering rooms, a small clinic, and bathrooms.
in northeast mexico, many religious organizations started building boarding schools to provide the children of the raramuri community with accommodations and an education. currently the schools have not integrated the traditions, language, and culture of the raramuri in to their program. the new school initiative is a plan to build a new primary school, for children ages three to twelve. the boarding school will feature a new curriculum which will integrate the customs and interests of the raramuri community with a twenty-first century education. the building will be constructed using local material such as wood, stone, gravel, corrugated metal sheets, and adobe brick, and it will be designed in such a way as to respect the traditional vernacular of the raramuri community. the flexible floor plan will include spaces such as an entrance hall, student space, open classrooms, computer room, and a medical greenhouse. the 370 square foot building is set up in such a way, that when the community grows, the building can as well, to continually meet the needs of the community.
with a rapidly increasing population and an ever encroaching urban development, the maasai tribes of kenya were leading a less nomadic lifestyle and were in need of a more permanent housing solution. itdg worked with the women’s groups to give support and develop ideas for new shelter technologies. itdg helped develop the use of a new building material in combination with traditional building methods. the new shelters were constructed from ferro-cement, reinforced by chicken wire. the use of the ferro-cement created a more permanent and waterproof roof. with the use of more durable, local materials the women’s groups could now focus on improving the community through small business creation and building education.

white orchid is an Island project in el nido, philippines, built as a safe harbor for girls rescued from the sex trade. the project buys islands, and builds schools for rehabilitation and education, along with school classrooms, the campus houses counseling rooms, an art wing, medical clinic and housing. part of the healing and rehabilitation process will be assisted by the participation in and cultivation of the schools botanical garden which is full of indigenous fauna.
the telemedicine clinic in achham nepal, is a resource to rural community members to get vaccines, receive yearly check ups, and eye exams, who otherwise could not or would be unable to seek these services in a larger town. along with exam rooms, the facility contains a pharmacy, multipurpose center, storage, library, offices, training rooms, counseling rooms and reception.

designed by paula cicuta, the homeless legacy center is a project originally developed to be a training facility for soccer teams visiting rio de janerio, brazil, for the 2014 world cup. the training facility would have ample practice space, exterior courtyards, and residential units. once the soccer vacate the complex, it would then be used to house and shelter the homeless living in rio de janeiro. the flexible plan would include single family residences, public spaces, activity rooms, and educational classrooms and resources.
due to the devastation that occurred in January 2010 to much of Haiti after a massive earthquake, a project was proposed that would provide an architectural prototype for rebuilding communities and Haiti’s society which was torn at its seams. The project was designed to address the numerous short term problems effecting the people of Haiti, along with the long term needs of the communities, using a similar technology and technique, many of these structures could be designed out of locally available materials, such as timber, bamboo and bricks. The project aimed at providing temporary emergency shelter, community gathering space, sanitation and provide clean water through a water treatment station.

To further reconstruction efforts in Haiti, Fabiano Lemes de Oliveira and a team of designers, put together a program for a shelter and community center which focused on providing safety to its users. Included in the program were multiple, enclosed private rooms, open public courtyards, along with enhanced education and community spaces. With reusable spaces the center strived to be vibrant and to promote comfort and healing.
the youth center of Nairobi, Kenya, was designed to train and **educate the youth** of the community, and keep them off the streets. The project was constructed from concrete CMU blocks and clay brick walls. Spaces included training classrooms, a library, computer labs, and courtyard. The cost of the constructed project was $150,000 [US].

designed for the **community** of Tamil India, this community center, built by Architecture for Humanity, had the ability to **serve** 115 families of the community. Spaces included a large indoor community hall, kitchen, offices, toilets and showers, daycare, worship space, a small clinic and a town square.
The goal for the Aga Khan Foundation and Architecture for Humanity was to design a community center for the village of Cabo Delgado in Mozambique. The project strived to improve the human spirit, increase awareness of climate and environmental changes, along with responding to the growing need of the community for clean water, power, shelter, health care and education. Using local, renewable resources and preserving the traditional architecture of the community, the project was able to teach residents improved construction techniques when building with earth and bamboo. This would extend a building’s lifespan along with addressing the design world’s current challenge of providing rural communities with a high quality of spaces and design. The project included eleven multipurpose learning centers, spaces for daycare, training classrooms, single family residences and public use spaces.
Pillaichavadykuppam is a village in Tamil Nadu, India; which was struck and devastated by the 2004 Indian Ocean tsunami, while there were no lives lost, there was significant damage done including the loss of 40 homes, 10 toilet stalls, 18 boats, and 35 catamarans. This devastation greatly effected the livelihood of the community, this mud brick and reinforced concrete community center and transitional living space was developed and constructed to help rebuild the community. The two buildings also included youth rooms, a multipurpose hall and a sanitation block. The building was detailed with a tiled roof, wooden lattice screens and painted vibrant colors, in a traditional fashion as to the rest of the community. The 1350 square foot building cost the village $22,800 [us] to construct.
the village of ambedker nager in india, suffered much trauma following the 2004 indian ocean tsunami. while there was no loss of life, the community suffered from lack of food due to a lose of crop, and they were also in need of shelter. the focal point of the whole development of the project was the community center which included a multipurpose hall, daycare and a kitchen. a second building was designed to house private residences. the two buildings totaled 4300 square feet and cost $11,330 [us] to construct.
architecture for humanity’s goal for designing and building this community complex for yodakandiya, sri lanka, was to **improve the human spirit**, along with addressing the humanitarian crises of the community caused by the 2004 indian ocean tsunami. in partnership with u.n. habitat, architecture for humanity and the local community built three community buildings containing a community center, library, medical center and preschool. the program was divided among three buildings to allow for greater natural ventilation for each space. this separation also allowed the public and private spaces to be distinguished from one another. the main, 3165 square foot community center comprised of a main hall, storage, kitchen and bathrooms. a secondary, 1735 square foot building housed the library, computer center and medical clinic. a third, more private 1815 square foot building housed the preschool, daycare, worship space and offices. included in the development of the project was a landscaped sports and recreation area for the community. the 6175 square foot center has the capacity to **help 300 people**. in total, the community complex cost $104,000 [us] to construct.
by studying and analyzing previous design projects and community building programs, a list of desired requirements for this terminal project could be formed.

The community center projects served between 50 and 300 people, roughly one-fourth to one-third of their community’s total population. Many of the centers were designed with temporary housing or incorporated single family residences into the design of the project.

Of the spaces provided in each, the community center’s program would include:
- a large multipurpose hall
- library
- kitchen
- training centers
- daycare facilities
- small medical clinic
- offices
- storage
- computer lab
- sanitation
- counseling rooms
- educational rooms

Housing and medical projects were also studied to view the basic and essential needs of a single family dwelling, and the support space needed for a small, outpost medical clinic.

Most of the homes were between 72 and 400 total square feet. Basic shelter provided living area and family gathering space. Some housing projects included a kitchen, water collection and retention, storage, and more private living quarters.

Medical clinic projects included such programming as:
- computer technician lab
- pharmacy
- medical equipment storage
- secure pharmacy storage
- administrative offices
- reception and waiting area
- exam rooms
- counseling rooms

The focus for many of these clinics was to treat common infections caused by a lack of sanitation and strenuous manual labor. Physicians also diagnosed eye, heart and skin problems. Each clinic served the communities specific medical needs.
the conclusion of these precedent studies led this terminal project to contain the following programmed spaces:

- multi-purpose hall
- educational rooms
- sanitation block
- private residences
- community resource offices
- storage
- small health clinic
- religious space
- library

This terminal project should also be designed as a quick response to a community's need for assistance after an earthquake. The built project should have an earthquake resilient structure along with having a flexible floor plan. The project should use locally available materials and should be designed in such a way as to respect the community's traditional architecture and building practices. Each facility should be a permanent fixture in the community and icon of safety.
“as with most natural disasters, those most affected are those who could least afford it”
earthquakes devastate a higher number of people around the globe than any other natural disaster. If an earthquake hits a large, densely populated city there is a potential for an increase in injuries and destruction. Eighty-one percent of all annual earthquakes occur along the circum-Pacific belt.

Along this belt lies some of the most populous nations in the world; including Chile, Japan, USA, and New Zealand. Major earthquakes hitting these areas can and have produced considerable damage. A major earthquake has the ability to collapse skyscrapers, factories, and power plants along with causing compound hazards which include aftershocks, soil liquefaction, tsunamis, landslides, floods, and adverse social-economic effects.

Tall buildings will typically sustain the least amount of damage if they are located directly over or in close proximity to the earthquake's epicenter. The greatest stress on a building is caused by the side-to-side shaking. Earthquakes produce two types of seismic waves: body waves and surface waves. Body waves travel through the interior of the earth, in a similar fashion to light waves emitted from a bulb. Surface waves travel across the earth's surface, affecting similar to water waves. P-waves and S-waves are types of body waves; primary and secondary waves that produce longitudinal and transverse forces, respectively. Rayleigh waves or a ground roll, are surface waves which travel as a ripple along the earth's surface. Love waves are a surface wave which moves across the surface of the earth in a back and forth or circular motion.

Buildings with thick, heavy walls do not resist shock waves very well, in a violent earthquake and they often collapse. Brick buildings are the most vulnerable. A building's structure must have a balance of flexible (ductile) walls and rigid (stiff) walls.

Buildings built on soft or filled-in soil tend to suffer more damage; as shockwaves are more easily transferred from the ground to the building's structure. Buildings constructed on bedrock suffer less damage due to the more firm and stable nature of the ground.

Devastation can continue for years after an earthquake. Economic, social, physical and psychological damage are a few of the factors which effect rebuilding efforts. Time of the initial earthquake, along with number and intensity of aftershocks must also be assessed when accounting for damages. Vulnerability factors for a city include location in relation to fault lines, adequate building practices, density of buildings, density of population, and use of public warning systems. Damage, in many cases is unavoidable. The goal in any earthquake-resistant design is to control damage to the point where the building will not collapse.
possible site locations were chosen based on their location, and their urgent need for aid and housing assistance, sites selected must vary in income level, total population, traditional customs, and community and housing structure, each site must have been struck and severely effected by an earthquake in 2010, so as to view the current needs of the global community, total building and property loss will also be considered.

based on severity and magnitude of an earthquake, possible site locations include:
- solomon islands
- haiti
- japan
- usa
- ecuador
- vanuatu
- chile
- nicobar islands, india
- papua, indonesia
- papua new guinea
- moro gulf, philippines
- northern sumatra, indonesia
- new zealand
largest earthquakes
magnitude 7.0 and greater
most active locations
Project sites

Movement: Circum-Pacific Belt

- Curepto, Chile
- Sibolga, Sumatra, Indonesia
- Christchurch, New Zealand
three sites were chosen to **compare** and contrast the effects building materiality, culture and poverty level have on a building’s design, structure and overall program layout.

with a list of site requirements ranging from a location near residential housing, to access of public utilities, and phases of program requirements; each community center can **start with the same goal**, of providing an earthquake resistant shelter, and transforming into a building that is **integrated** into the overall **design influences of the community**.
Curepto, Chile  
m. 8.8  February 27, 2010
- Total population: 16,465,000  
- Affected earthquake: 4,653,500  
- Death toll: 800  
- Number of homes destroyed: 500,000  
- Population living below poverty line: 18.2%

Sibolga, Indonesia  
m. 7.8  April 6, 2010
- Total population: 228,864,000  
- Affected earthquake: 2,000  
- Death toll: 81  
- Number of homes destroyed: 103,500  
- Population living below poverty line: 20%

Christchurch, New Zealand  
m. 7.2  September 4, 2010
- Total population: 4,393,000  
- Affected earthquake: 372,000  
- Death toll: 0  
- Number of homes destroyed: 1,000,000
site selection
three global sites
“we are dealing with an urgent problem of our epoch, nay more, with the problem of our epoch. the balance of society comes down to a question of building.”

Le Corbusier
Chile
The February earthquake affected six of Chile's thirteen regions. Of the six regions, Maule sustained the most damage, including the loss of 800 lives. People killed in their own homes accounts for ninety percent of the overall death toll. 16,465,000 people live in Chile, 80 percent of whom were affected by the earthquake (4,653,500 people). As a result of the February earthquake approximately 500,000 homes were destroyed or sustained structural damage, and are now uninhabitable. International aid and humanitarian crisis organizations sent and assembled 25,000 emergency shelters. As the winter season approached, the temporary (tent) shelters were proving inadequate at providing enough safety from the harsh weather conditions. The February tremor caused surface faulting, ground vibrations, liquefaction, and landslides. Aftershocks, though none causing additional significant damage, continued for days following the M 8.8. A month after the initial earthquake 130 aftershocks were registered more than half were of at least M 6.0. The earthquake epicenter was located 200 miles west of Santiago, just off the Pacific coast. Due to its location, the earthquake triggered a tsunami, further damaging ports and coastal buildings and property. Local homes are built with either reinforced clay block or are wood framed with mud and plaster infill. Larger government buildings are constructed with a concrete frame.

Curepto
Curepto is a small rural community in Maule. It is bordered by the Mataquito River to the north, Constitución to the south, Curepto lies in the central valley. Central valley is a longitudinal depression between the Chilean coastal mountain range and the Andes mountains. Cerro Pumunul, 585 meters, and Huilhuil, 555 meters are the tallest peaks of the mountain range. With the tall peaks, travel, and communication are difficult. Access is even more restricted during bad weather. This farming community is surrounded by dense forestry including oak-hualu, oak rauli, quillay and cohilue trees. The average temperature for this region remains between 5 and 24 degrees Celsius. A harsh winter season extends from June until August. Many of the government buildings in Curepto are built in a Spanish Colonial style of architecture. In 2008, the total population of Curepto was 10,821 people. Thirty percent (3,157 people) of whom lived in Curepto's urban areas. Seventy percent (7,655 people) of the population live in rural areas, including working farms. This results in a community density of 26.1 people per square mile. Curepto has a decreasing population of approximately 1,470 people over the past ten years. This decrease has been attributed to shorter life spans, diseases and natural disasters, which include landslides, earthquakes, and flooding.

Curepto, Chile
images of devastation in the community
sibolga, indonesia

site
Indonesia

Indonesia is the largest archipelago in the world, made up of a string of 17,508 islands, 6,000 of which are inhabited islands.

As of the 2010 census, 237,556,363 people live in Indonesia. Indonesia straddles the equator while dividing the Pacific and Indian oceans. The m. 7.8 earthquake took eighty-one lives.

It is the fourth most populous country in the world, yet it struggles with constant poverty and housing shortages. Twenty percent of the population lives below the poverty line; defined as living off $1.50 [us] a day. In total, the country is in need of more than 8.1 million housing units.

Approximately 100,000 homes were destroyed, along with 300 schools and 500 office buildings sustaining damage as a result of the April earthquake.

The m. 7.8 earthquake in April (2010) brought along five major aftershocks, registering at least m. 5.2. The tremor struck out at sea, around 125 miles west-northwest of Sibolga. Indonesia lies along one of the most active fault lines in the world.

Between the Sumatra trench and Mount Kerinci, northern Sumatra is constantly moving, seeing twelve major earthquakes this year.

Most residences are built from wood and plywood frames and clay tiled roofs which sit atop wooden piles.

Sibolga

Sibolga is a rural port community on the west coast of northern Sumatra. The Indian Ocean coast rises to meet the rolling hills and small mountains located to the east of Sibolga. The Bukit Barisan mountain range runs the length of the island; containing active volcano Mount Kerinci. Sibolga is surrounded by beautiful beaches and coral gardens.

The island of northern Sumatra has an area of 27,675.8 square miles. With a population of 12,985,075 people the density of this island is around 469.5 people per square mile.

This community is home to many fisherman and small crop farmers. Much of northern Sumatra is covered with coffee farmers and dense rainforest. Sibolga and northern Sumatra were struck and devastated by the 2004 Indian Ocean earthquake and tsunami. Sibolga enjoys a mild tropical climate with cooler months ranging from November through March.

Many of the new residences constructed are built from unreinforced clay brick masonry. Buildings of this type typically experience severe damage or collapse during an earthquake. During an earthquake many buildings collapse due to the poor soil condition and soft, loose soil type which makes up the much of the island.

Sibolga, Indonesia
images of devastation in the community
christchurch, new zealand
New Zealand has a total population of 4,367,079 people. The early morning September earthquake caused more than $4 billion [NZ] in damage. New Zealand has over 14,000 earthquakes in a given year, around 150 are over a m. 5.0 and felt by the population. Of the 160,000 total homes of Christchurch, the September earthquake damaged or destroyed over 100,000 of them. Though no deaths occurred as a result of this earthquake, there were ten injuries. Most buildings sustained damage from collapsing brick walls, falling stone, and cracked or collapsed roofs. Due to its constant shaking, New Zealand maintains a high standard of seismic design. The forty-eight hours following the m. 7.2 quake, sixty-three aftershocks occurred, five registering above a m. 5.0. As a result of the earthquake, the ground up-heaved eleven feet, causing permanent displacement and creating new surface fault lines.

The earthquake’s epicenter was twenty-five miles west of central city in Christchurch.

At 10 am local time, a state of emergency was declared, the army assisted in immediate search and rescue efforts, evacuations began of the business district, schools closed and response teams set up resource tents in streets.

Seventy-five percent of the city lost power, major damage was also done to city’s sewer, water and gas utilities.

Christchurch

Christchurch is a large urban and business community in the Canterbury region. It is the largest city on New Zealand’s South Island and the second largest country wide. As one of New Zealand’s oldest cities, Christchurch has a blend of modern and gothic revival styled architecture. It is often referred to as a compact metropolis that was planned around an expansive parks system.

Central city is considered the business district of the city with only a few multiple family residences.

Central city is an area around the cathedral square of Christchurch, between Bealey Avenue, Fitzgerald Avenue, Moorhouse and Deans Avenue.

Christchurch is bordered to the south by the Southern Alps, the Pacific Ocean to the east, and the Canterbury Plains which extend to the north and west, along with extending to the Banks Peninsula.

The average temperature is around 12 degrees Celsius with an average of 648 mm of rainfall per year. New Zealand experiences a mild climate with a summer season stretching from December through February.

The employment demographic is as follows: 30,136 people work in manufacturing, 23,307 in health and community services and 17,130 work in construction.

Christchurch has a territorial area of 550.6 square miles, and an urban area of 174.5 square miles.

The elevation rises from 0 feet to 3,018 feet from the ocean to the Canterbury Plain located to the west of the city.

Christchurch has a population of 348,400 people and an urban density of 2,212 people per square mile.
“the main purpose of development should be quality of life for the large majority of people. if you don’t have a generous view of cities, then you don’t have a generous view of people”

Jaime Lerner
sun
ventilation
site
medical  talca: 50 km
market
worship
school  talca: 56 km  constitucion: 45 km

[60]
site
medical sibolga: 2.3 km  7.8 km
market
worship sibolga: 2.5 km
school padang sidempun: 72 km
sun
ventilation
christchurch, new zealand

site
“People should think things out fresh and not just accept conventional terms and the conventional way of doing things.”

R. Buckminster Fuller
the project’s programming process would be a constant cycle of development and abridgement with the intent that the building would constantly be meeting the immediate needs of the community.

phase one_ start
if the project started at phase one, development and construction would begin following the devastation of an earthquake. the building’s program would be set up to provide the community with transitional housing units. as residents build their permanent dwellings off site and vacate the center, the building would, over time, transition to a community resource center.

phase three_ start
if the project started at phase three, development and construction would begin preceeding the impending threat of an earthquake. a facility such as this center would be placed in communities which in recent history have faced the devastation of an earthquake and are in imminent threat of another earthquake, and would greatly benefit from the spaces and services provided by the center. the building’s program would be set up to provide the community with educational and training spaces along with living assistance programs. the building, once established, would then be able to transition into living units for community residence displaced from their homes in the aftermath of an earthquake.
program transition
during research and a site analysis of each community it was noted that the communities needed each of the spaces provided. adjustments were made to each program’s square footage allotment to allow more community specific needs to be met. these spaces were integrated into a phase of the program, in order to meet the immediate and general needs of that community.

the goal for each phase of the building is to meet the community’s needs while having a plan for development to also meet that community’s long term needs.
community center
  serving 200 to 300 people

phase one: immediate response
  housing
  toilets and showers
  multipurpose hall
  aid distribution

phase two: transitional phase
  kitchen
  offices
  gathering rooms
  multipurpose hall expanded
  housing reduced

phase three: substantial development
  educational rooms
  training rooms
  staff room
  rotational medical clinic
  housing units removed
  multipurpose hall expanded
  worship space
phase one: immediate response phase
- housing: 60 to 80 rooms at 100 sq ft; 8000 sq ft
- toilets/showers: approx. 50 stalls; 900 sq ft
- multipurpose hall: 270-300 sq ft
- aid distribution: 300-350 sq ft
  - storage: 50-80 sq ft
  - delivery access
- worship space: 120-150 sq ft
  - covered and partially enclosed outdoor area
- outdoor kitchen/courtyard: 100 sq ft
- front entry: 80-100 sq ft

phase two: transitional phase
- kitchen (indoor): 100-150 sq ft
- offices: 100-120 sq ft each
  - community center staff: 4 offices
  - aid workers: 4 offices
  - women’s center and clinic staff: 2 offices
- storage: 200-250 sq ft
- gathering rooms: 4 rooms; 150-200 sq ft each
- counseling rooms: 2 rooms; 50 sq ft each
- multipurpose hall: expanded to 600-800 sq ft
- housing: reduced to 30 to 40 rooms; 4000 sq ft
  - community members are moving to private residences

phase three: substantial development phase
- library: 150-180 sq ft
- daycare: 200-220 sq ft
  - serves only staff, and educational classrooms
- educational rooms: 4 rooms; 180-200 sq ft each
  - focus of future expansion will be on the addition of classrooms
- training rooms: 2 rooms; 150-180 sq ft each
- women’s rooms: 2 rooms; 120-150 sq ft each
- staff room: 80-100 sq ft
- rotational medical clinic space: 250-300 sq ft
  - eye, vision, heart exams, vaccinations, minor medical
- utilities closets: 2 closets; 40-60 sq ft each
- dining expands to serve 180 to 200 people
- housing: entirely removed with the exception for live-in staff
- multipurpose hall: expanded to 1200-1400 sq ft
- worship space
seismic design

“visiting the site of the earthquake, the first thing that struck me was just how important a responsibility we architects have on the very basic level of providing safety and security for people.”

Tadao Ando
there are many factors which hinder the improvement for seismic design in developing nations. those factors include:

- poverty
- lack of technologies
- non-engineered buildings do not meet current seismic design codes
- many buildings are built using heavy, brittle and often weak materials
- in many countries, earthquake resistant designs would require introducing new building practices
- many masonry infill walls are too brittle and not sufficiently separated from the structural frame
- with an uneducated workforce and lower quality control it is difficult to maintain an adequate standard of seismic construction
building in developing countries
Seismic resistant construction should be kept as simple as possible. Structures should be designed to resist the moderate earthquake magnitude forces of the region. The choice of construction materials should not only be based on the design, but also; the availability of materials, the skill of the local labor force, and material cost.

As the ground on which a building rests is displaced the base of the building moves along with it, causing the top portion of the structure to sway back and forth. One way this can be done is by restricting or guide the building to move in one way or direction. Main structural elements are designed to have sufficient ductility; allowing a structure to sway during earthquakes.

To resist torsion due to earthquake forces, a building’s structure should be designed with center stiffness. A structure should be designed with a continuous load path for its forces, adequate strength and stiffness can be provided from the top down to a building’s foundation.

Damage is unavoidable; disturbances should be controlled and allowed to occur at the right places. This is commonly referred to as a single degree of freedom. Seismic reinforcing is designed for bi-lateral forces; s-waves and p-waves.

Basic factors for proper seismic behavior of a building include: simplicity, symmetry of building, ductility, and transfer of the lateral loads through the building to the ground without excessive rotation. A design layout should avoid elongated building plans or elevations, small, uniform masses, re-entrant corners, center stiffness.

If a more complex design for a building is desired, the building’s structure should be broken into more simple forms, with smaller masses, and structural symmetry.
design considerations
loads are transferred along shortest path from diaphragms to vertical members, then to ground. horizontal members in a building include diaphragms such as floor slabs, horizontal bracing, and staircases. a building’s vertical elements include shear wall systems, braced framing walls, and moment-resisting frames.

if an exterior wall is curved, a bonded beam can use the rounded geometry to transfer forces primarily by arch action from the continuous wall to the ground plane. An arch gains strength on its convex side, and looses significant strength when forces are applied to its concave side. 

great care should be taken to avoid designing short columns. short columns are the result of a flexible frame which is only partially infilled with a more brittle material, to create a clear story, rather than allowing the framing columns to flex of the entire length of the member, a focus point is created for earthquake forces, ultimately resulting in joint failure.

the m.m. (moment magnitude) scale measures the scale and intensity of and earthquake based upon the amount of energy released. the severity of an earthquake is evaluated by measuring the magnitude; or the amount of energy released during the earthquake, and its intensity; the effects caused by ground shaking.

a rigid building describes a structure in which every part of the building and the ground deflect the same distance. flexible buildings are structures in which different materials deflect by different amounts as compared to one another and the ground.

strength: property of an element to resist force. stiffness: property of an element to resist displacement. ductility: the ability of a material to undergo large inelastic deformations without significant loss of strength or stiffness. damping: the process by which free vibrations steadily diminish.
design considerations
an earthquake resistant structure has the ability to resist the effects of ground shaking, although it may be severely damaged it is designed to not collapse in a severe quake.

horizontal members should fail prior to vertical members. this recommended design practice utilizes stronger columns, and less strong beams. in the event of severe structural damage the building would remain standing while non-structural elements would collapse, doing so in a more controlled fashion.

in a strong beam, weak column design, beams and slabs generally don’t fall down even after severe damage at elastic hinge positions, though the columns will rapidly collapse under the vertical loading, causing structural collapse.

load bearing shear wall system are the most common building system for low rise structures. all walls are load bearing. some walls maybe shear walls, which means they are load bearing while also resisting gravity and lateral loads.

shear walls have large in-plane stiffness and resist lateral loads and control deflection efficiently.

isolating a building’s base detaches the structure from the ground in such a way that only a small degree of seismic ground motion is transmitted throughout the building.

flexible materials will not have a significant affect on a building’s structure. light weight partition walls pose less danger to building occupants but need to be separated from the structure to protect them from damage.

pile foundations are designed based on the considerations of vertical and horizontal stresses a building will undergo and the structural integrity of the foundation. base shear forces are resisted by the lateral bearing placed on the pile foundation.
wood: 1-5 stories, suitable for light-weight construction. because of its relatively low strength and stiffness as compared to reinforced concrete or steel construction, several long or many shorter walls may be required to resist seismic forces. particularly appropriate for buildings where function dictates a cellular layout. a *popular and cost-effective material* for seismic construction but the wall lengths required are longer than those using a stronger wood-based product such as plywood. wood or steel framing to form shear walls in light weight framed construction.

moment-resisting frames are frames in which the beams, columns, and joints resist earthquake forces, primarily by flexure. this system is recommended only up to thirty-stories due to a limitation on the drift. dual systems consist of *moment-resisting frames either braced or with shear walls*. the coupling of the two systems completely alters the moment and shear diagrams of both the walls and the frame.

steel frames are used for building heights between 4-8 stories, steel plate walls can strengthen existing buildings. used in a moment resisting frame, were the frame is allowed to flex to a degree. steel has a medium to high ductility; reinforced concrete has a high ductility, reinforced masonry has a medium to low ductility, wood has a medium to high ductility.

reinforced concrete [RCC] is used for building heights between 1-20 stories, one of the more reliable materials for medium to heavy construction. it has a high level of ductility which enables designers to achieve the shortest wall lengths. reinforced concrete walls are usually cast in place. precast concrete panels including tilt-up panels typically one to three stories high and only perform well if they have strong enough ties to the rest of the structure.

reinforced masonry: 1-6 stories, popular where long wall lengths are achievable. as the strength of masonry units and grout infill reduces, required wall length increases. construction quality control requires special attention. brittle *infill materials* need to be sufficiently separated from the frame.
design considerations
schematic design
many buildings constructed in Chile use a **timber frame**, and the community center in Curepto would be constructed in the same fashion. The timber stud walls would be infilled with **earthen bricks** and the frame could be strengthened and stiffened by reinforced, poured-in-place **concrete shear walls**.

The use of a moment resistant timber frame with stiff shear walls is a structural system known as a dual framing system, which combines the flexibility of a moment resistant frame with the stiffness of a shear wall system.

Timber frames are designed to be flexible and use **easily available materials** for construction. Reinforced shear walls provide **good stiffness** and are suitable for most structures in earthquake prone areas as it provides high level earthquake resistance.

Bearing walls are of stud wall construction, braced diagonally in a vertical plane. Height limit of bearing walls are two stories and attic. Use of a timber frame require light roof construction. Maximum spacing of bearing walls or columns should be between 4 and 6 meters. For long spans, heavy stressed metal rings or wooden disc dowels are recommended for joint connectors.

Timber buildings suffer more earthquake damage when located on soft ground rather than hard ground.

Shear walls should be designed for greater strength against lateral loads that other ductile concrete frames. At minimum a shear wall should be no less than 150 millimeters thick.

Timber studs used for load bearing walls should have a minimum finished size of 40 millimeters by 90 millimeters. Corner posts should consist of three timber pieces, two being equal in size to the studs used in walls meeting at that corner; the third piece being of a size to fit so as to make a rectangular section.

Deep foundation designs rely on normal structural and geotechnical static design techniques to resist earthquake forces, also taking into account seismically enhanced pressure of the surrounding soil.
design considerations

curepto, chile
conceptual structural design

8”x 8” timber column

8”x 12” timber beam
RCC shear wall
8" x 8" timber column
18" o.c.
timber frame stud wall
earth infill

conceptual floor plan design
Curepto, Chile
concept sketches
curepto, chile

simple program massing integrated with building structure
sibolga, indonesia
structure diagram and conceptual floor plans
in a similar fashion to many of the buildings in sibolga, the community center would be constructed from poured-in-place concrete **shear walls with a concrete column, moment-resistant internal frame.**

Timber framed stud walls would support all exterior walls and would be infilled with **masonry** blocks. The use of a moment resistant frame with stiff shear walls is a structural system known as a dual framing system, which combines the flexibility of a moment resistant frame with the stiffness of a shear wall system.

Buildings slabs are elevated off the ground to increase air circulation through out the space. This also allows the structure to remain dry and escape seasonal flood waters and some tsunami waves.

A pile column foundation was chosen to tie the center’s structure and slab to the ground. This system was chosen based on the considerations of **horizontal and vertical stresses** that would be placed on the structure and the integrity required for the building.

In pile foundations base shear forces are resisted by the lateral bearing forces placed on the pile footings. Footing construction should be designed with sufficient continuity with reinforcement provided between the piles and pile caps.

With an elevated building slab, squat columns can form between the foundation piles and the structural frame caused by the slab. Deep foundational footings can deform the surrounding soil during an earthquake if the footings are placed in soft or poor quality soil.

Masonry buildings are easy to use in many countries as materials and a trained labor force in masonry construction is readily available. Reinforced masonry frames are designed to span larger vertically distances and transfer loads from the roof through the floor and down to the foundation.

Infill walls refer to a **framed structure which is in-filled with stiff construction**, typically masonry units such as brick, stone or clay block. Strength and energy dissipation capacity of infill walls is much higher than a bare stud frame, which is very effective against earthquake forces. Brittle infill materials must adequately separated from frame. Damage sustained to the buildings structure will be directly related to an infill material’s stiffness and its ductility.
design considerations
sibolga, indonesia
conceptual structural design
conceptual floor plan design
sibolga, indonesia

phase one

phase three

8" x 8" timber column
18" o.c.

RCC shear wall

moment resistant frame

12" x 12" RCC column

RCC shear wall

timber frame screen walls

masonry infill

section
sibolga, indonesia

simple program massing integrated with building structure
the structural design for the community center in New Zealand is that of the **steel zippered-v frame with reinforced poured-in-place concrete shear walls**.

This design system is known as a dual framing system, which combines the flexibility of a moment resistant frame with the stiffness of a shear wall system.

Base isolation systems are designed and used to detach and **isolate a building from the ground** in such a way that only a small portion of the seismic ground motion are transferred up through the building. These types of systems change the osculating period of the building from shorter, more forceful periods to longer, less forceful periods.

Rubber (elastomic) pads and dampers are two types of base isolation systems which either utilizes sliding plates and a friction pendulum system or energy dissipaters such as hydraulic or electro-rheological fluid dampeners, steel dampeners, or shape memory alloy dampers.

Steel has a high strength to weight ratio which makes it an **ideal building material** in seismic areas. With its cost and need of a skilled labor force, steel framing is not used extensively in many developing countries.

Steel frames should be designed with weaker beams and strong columns. Diaphragms should fail before columns, this design allows for the **structure to remain standing** while non-structural members are destroyed.

X-frame and zippered-v frames perform better against seismic loads as compared to other framing designs, such as concentric braced frames and the chevron design, which are either too brittle or allow for excessive flexure around a beam’s mid-span.

Structural designs for a 30 foot column to column span with a building height up to 30 foot, would approximate a 12 inch by 12 inch steel w-shaped column with a w-shaped beam having a depth of approximately 12 inches.

When using complex building geometry where re-entrant corners are present, the structural design should be separated into simple geometry components which are **tied together** with separation joints.
RCC shear wall
moment resistant frame
12"x12" steel beam

conceptual structural design
RCC shear wall
moment resistant frame
12"x12" steel column
30" o.c

Christchurch, New Zealand

Conceptual floor plan design

Phase one

Phase three
concept sketches
christchurch, new zealand

simple program massing integrated with building structure
the goal for the continuation of this thesis project is to design and architecturally detail plans for a community resource center in Curepto Chile.

the structure and framing materials for the design of the community center in Chile is that of the timber frame with a reinforced concrete shear wall. The timber frame, with earth infill or unreinforced clay masonry, is the most common building material type found around the globe.

in many areas, such as Chile, timber is easily accessible, and the most cost efficient material choice for smaller structures. There are a variety of timber construction types ranging from thatch construction with mud stone to post and beam frame construction with or without infill to the most common type of timber construction, the stud-wall frame.
where to go from here

terminal project intent and development
project development
map depicts, on a global scale, the use of traditional timber frame construction for light weight structures.

most of chile resides in this zone of timber frame construction. on a whole, chile occupies 292,183 square miles, covering 2,700 lateral miles, while only stretching 109 longitudinal miles.
based on geographic location, the diagram shows the geographic break-down of the country based on regional climate.

chile has three major climate regions; a northern, central and southern region.

the northern desert region experiences a steady dry climate. much of this zone is occupied by the atacama desert, one of the driest places on earth. average rainfall is between zero and one millimeter per year. this sterile growing environment is bounded by the chilean coast mountain range and the andes mountain range.

the mediterranean climate of the central region experiences a winter season from june until august with temperatures averaging 7 degrees celcius. summer months range from december to march with an average temperature of 20 degrees celcius. still bounded by the andes mountains to the west this region recieves anywhere from 20 millimeters to 253 millimeters of rainfall per month.

much of the southern zone is a tropical plain which experiences cold, but mild winters strong winds, and year around rainfall averaging 1,118 millimeters.
based on geographic location, the diagram shows
the local practices of heating and cooling.

in many regions of chile, central heat and air is too
expensive and therefore is only used in high-end
commercial construction and government or public
buildings.

the local disposition is the idea that an occupant
conditions themselves in a space rather than
conditioning the space to fit their comfort. in chile, if a
space is cold, an occupant would dress warmer, and
in some locations use a space heater to warm up the
room. equally, if the space is too warm, an occupant
would dress accordingly, open windows to naturally
ventilate the room and/or turn on a fan.

for the purposes of the site in curepto, the community
center project will use natural ventilation by use of
operable windows. the building’s ventilation would
be assisted with fans in some of the spaces, and
subsequently the centers spaces would be heated
with the assistance of space heaters.

[124]
based on geographic location, the diagram shows the use of local materials in traditional building construction.

many buildings in the northern zone are constructed in the environmental setting of a desert and are therefore built out of stone, straw and mud.

the mediterranean climate of the central coast and mountain zone lends itself to buildings being constructed from adobe brick sealed with mud plaster and adobe tile.

the plains of the southern zone experiences a rainy climate and therefore many buildings are of a timber frame construction infilled with stiff masonry and then clad with timber, stucco or stone.
north zone
stone
straw
mud
central zone
adobe
tile
south zone
wood

curepto, chile
local building materials
the diagrams display the locations of building material manufacturers along with their suppliers and storehouses. the maps demonstrate the availability of each material before and after a disaster. timber, concrete, glass and steel is shipped and transported via cargo ship, train and semi-truck.

as with any project, urban or rural, transportation of materials to a site is a challenge. traffic patterns and site location are just a few of these challenges.

transporting materials to the project site after an earthquake is dependent on travel and road conditions. tracks may be derailed and roads upheaved. many mountain communities, during harsh winter months and rain storms have limited road access.
“people should think things out fresh and not just accept conventional terms and the conventional way of doing things”

R. Buckminster Fuller
the project’s programming process would be a constant cycle of development and abridgement with the intent that the building would constantly be meeting the immediate needs of the community.

phase one_ start
if the project started at phase one, development and construction would begin following the devastation of an earthquake. the building’s program would be set up to provide the community with transitional housing units. as residents build their permanent dwellings off site and vacate the center, the building would, over time, transition to a community resource center.

phase three_ start
if the project started at phase three, development and construction would begin preceding the impending threat of an earthquake. a facility such as this center would be placed in communities which in recent history have faced the devastation of an earthquake and are in imminent threat of another earthquake, and would greatly benefit from the spaces and services provided by the center. the building’s program would be set up to provide the community with educational and training spaces along with living assistance programs. the building, once established, would then be able to transition into living units for community residence displaced from their homes in the aftermath of an earthquake.
program transition
the project programming was revisited. the initial program was very general and did not provide space for community specific needs. the building needed to work for the population of curepto, rather than the people having to work around spaces they didn’t need while the building lacked spaces they desperately needed.

during research and a site analysis of the commune of curepto, it was noted that the community needed each of the spaces provided in the program in addition to more public gathering spaces; specifically, outdoor gathering space. these spaces were integrated into each phase of the program from seating areas, and an increase in overall square footage devoted to public circulation spaces; along with the development of multiple courtyards.

the goal for each phase of the building still remains the same; to meet the immediate needs of the community while having a plan for development to also meet that community’s long term needs.
community center
serving 200 to 300 people

phase one: immediate response
housing
toilets and showers
multipurpose hall
aid distribution
outdoor gathering space

phase two: transitional phase
kitchen
offices
gathering rooms
multipurpose hall expanded
housing reduced
outdoor gathering space

phase three: substantial development
educational rooms
training rooms
staff room
rotational medical clinic
housing units removed
multipurpose hall expanded
public courtyards
worship space
phase one: immediate response phase
- housing: 60 to 80 rooms at 100 sq ft; 8000 sq ft
- toilets/showers: approx. 50 stalls; 900 sq ft
- multipurpose hall: 270-300 sq ft
- aid distribution: 300-350 sq ft
  - storage: 50-80 sq ft
  - delivery access
- worship space: 120-150 sq ft
  - covered and partially enclosed outdoor area
- outdoor kitchen/courtyard: 100 sq ft
- front entry: 80-100 sq ft
- outdoor gathering spaces

phase two: transitional phase
- kitchen (indoor): 100-150 sq ft
- offices: 100-120 sq ft each
  - community center staff: 4 offices
  - aid workers: 4 offices
  - women’s center and clinic staff: 2 offices
- storage: 200-250 sq ft
- gathering rooms: 4 rooms; 150-200 sq ft each
- counseling rooms: 2 rooms; 50 sq ft each
- multipurpose hall: expanded to 600-800 sq ft
- housing: reduced to 30 to 40 rooms; 4000 sq ft
  - community members are moving to private residences
- develop public outdoor spaces

phase three: substantial development phase
- library: 150-180 sq ft
- daycare: 200-220 sq ft
  - serves only staff, and educational classrooms
- educational rooms: 4 rooms; 180-200 sq ft each
  - focus of future expansion will be on the addition of classrooms
- training rooms: 2 rooms; 150-180 sq ft each
- women’s rooms: 2 rooms; 120-150 sq ft each
- staff room: 80-100 sq ft
- rotational medical clinic space: 250-300 sq ft
  - eye, vision, heart exams, vaccinations, minor medical
- utilities closets: 2 closets; 40-60 sq ft each
- dining expands to serve 180 to 200 people
- housing: entirely removed with the exception for live-in staff
- multipurpose hall: expanded to 1200-1400 sq ft
- courtyards: develop outdoor spaces
  - worship space
long term needs: community development spaces

programming
“all architecture is shelter, all great architecture is the design of space that contains, cuddles, exalts, or stimulates the persons in that space”

philip johnson
chile

phase one_immediate response phase

[140]
floorplan design
chile

phase two, transitional phase

[142]
floorplan design
chile

phase three_ substantial development phase

[144]
floorplan design
"architecture starts when you carefully put two bricks together, there it begins"
Ludwig Mies van der Rohe
the floor plan depicted shows the community center during phase one. the structure plan for the project remains the same throughout each of the building phases. the only change to the building’s plan comes from the use of partition walls used in combination with permanent timber stud walls and shear walls. the poured in place concrete shear walls framing each of the buildings four nodes provide lateral stability for the structure against any ground movement. these walls along with the interior stud walls and roof load is then supported by an 18 foot by 18 foot timber column and beam grid. the glass curtain wall which is elevated over the height over the four nodes is supported by the using the same timber frame grid. the glass curtain wall is also supported by aluminum mullions and frame.
RCC shear wall
8"x 8" timber column 18" o.c.
glass curtain wall
lightweight partition wall
timber frame stud wall
RCC shear wall

structural design
structural design
exploded isometric shows each layer of materiality for the community center. starting with the glass curtain wall and structure to the layers of the roof system. the diagram shows the interaction between the three wall types; the concrete shear walls, timber stud walls and partition walls down to the footings and foundation.

the plan portrays the interaction of each of the structure members of the buildings, between the timber joists and beams to the concrete shear walls.

structural diagram
curepto, chile
floorplan
exploded isometric

[152]
“there are three forms of visual art: painting is art to look at, sculpture is art you can walk around, and architecture is art you can walk through”

dan rice
images show examples of local projects found in Valparaiso, Santiago, Concepción, Talca and Los Angeles. These projects were chosen because of their expression of form, use of daylight in an interior space, lighting screens, and use of local materials.

By critically looking at these projects, concepts began to form for the community center project, from a color palette and use of materials to an overall gesture of form for the building.
contextual design images
phase one exterior view

image [a] is a view from the southwest corner of the front courtyard showing the entrance to the community center.
building design
image [a] is a view from the southwest corner of the front courtyard showing the entrance to the community center.
phase three _ exterior view

image [a] is a view from the southwest corner of the front courtyard showing the entrance to the community center.
phase one exterior view

image [a] is a view of the interior courtyard between the west entry building and the east secondary building looking north.
building design
phase two_ exterior view

image [a] is a view of the interior courtyard between the west entry building and the east secondary building looking north.
phase three_ exterior view

image [a] is a view of the interior courtyard between the west entry building and the east secondary building looking north.
building design
phase one_ interior views

image [a] is a view from the front entry seating area looking toward the worship area and aid building.

image [b] is a view of a seating area in the main hallway.

image [c] is a view down the main hallway of the community center looking toward the interior courtyard.
building design
phase two_ interior views

image [a] is a view from the front entry seating area looking toward the worship area and aid building.

image [b] is a view of a seating area in the main hallway.

image [c] is a view down the main hallway of the community center looking toward the interior courtyard.
building design
phase three _ interior views

image [a] is a view from the front entry seating area looking toward the worship area and aid building.

image [b] is a view of a seating area in the main hallway.

image [c] is a view down the main hallway of the community center looking toward the interior courtyard.
phase one_ exterior views

image [a] is a view from the northwest corner of the front courtyard showing the entrance to the community center.

image [b] is a view from the east side of the site looking towards the rear of the community center.

image [c] is a view between the community center and the aid building of the front primary and secondary courtyards.
phase two: exterior views

image [a] is a view from the northwest corner of the front courtyard showing the entrance to the community center.

image [b] is a view from the east side of the site looking towards the rear of the community center.

image [c] is a view between the community center and the aid building of the front primary and secondary courtyards.
phase three _ exterior views

image [a] is a view from the northwest corner of the front courtyard showing the entrance to the community center.

image [b] is a view from the east side of the site looking towards the rear of the community center.

image [c] is a view between the community center and the aid building of the front primary and secondary courtyards.
building design
“architecture is a process of giving form and pattern to the social life of the community. architecture is not an individual act performed by an artist-architect and charged with his emotions, building is a collective action”
Hannas Meyer
an exploded isometric details the components of a standard door partition and wall partition unit.

each door unit contains an eight foot wood framed door which is joined to two metal plates. each metal plates can be fastened to a stud wall by eight steel bolts. a two foot by three foot sheet of hollow polycarbonate is then attached to each door unit using a steel angle bracket and five steel bolts. the translucent polycarbonate sheet allows light to filter into each room of the community center.

partition walls would be available in two standard sizes; two foot and three foot units. each partition wall contains a 'c' bracket which would allow a wall to connect with another. joining multiple partitions together would allow a greater open space to be broken into smaller sized rooms without the need of intermittent stud walls. partition walls can be fastened to a stud wall by using a series of angled brackets attached to the partition wall and stud wall with steel bolts. strips of rubber sealant supported by a backing rod would create a cushion between the partition walls and the stud walls, absorbing any shaking the building may undergo. each eight foot tall wall unit would be topped with a sheet of hollow polycarbonate, again to allow light to filter into the space.

each of the 180 units, when not in use can be stored on site.

the isometric view shows a partition wall and door unit joined together.

plans, and elevations, detail each unit available of partition wall system.
rubber sealant with backing rod
steel bracket
hollow polycarbonate sheet
taped gypsum board
steel bracket and bolts
timber stud frame with rock wool
hollow wood frame door
steel plate and bolts
hollow polycarbonate sheet
partition wall system
phase one: partition wall plan
dividing living units
partition wall layout

phase one: immediate response

chile
phase two  partition wall plan
enclosing previous doorways
creating classrooms
dividing living units
creating storage
partition wall layout

chile

phase two_ transitional phase

phase one

phase two

phase three
phase three: partition wall plan
- enclosing previous doorways
- increasing classroom size
- dividing storage
partition wall layout

chile

phase three_ substantial development

[191]
landscape design

“architecture is a visual art, and the buildings speak for themselves”

julia morgan
phase one _ landscape plan
maintain five existing evergreen oak trees

phase two _ landscape plan
maintain five existing evergreen oak trees
addition of mauqi shrubs
addition of courtyard and interior planters
addition of jarava ichu grass in planters

phase three _ landscape plan
maintain five existing evergreen oak trees
addition of remaining shrub material, and grasses
addition of all perennial flowers, and cacti
drawing represents landscape design for phase three of the community center
**Grasses**

*Bear Grass (Nolina microcarpa) Agavaceae Family*
- Shaggy, clump grass, evergreen, 3-6 foot tall, spreads up to 8 foot, narrow grass like leaves, with curly strings and raspy teeth along margins, full sun
- Hardy ornamental grass, upright and grows in a clumping form, green foliage turns bright red-orange in the fall, magenta summer plumes

*Jarava Ichu (Jarava ichu) Agavaceae Family*
- Highlands grass, clump forming reaching a height between 12 and 20 inch, turns a bronze yellow color in the fall

**Cacti**

*Red Yucca (Hesperaloe parviflora) Agavaceae Family*
- Narrow evergreen leaved yucca with white thread like hairs along leave edges, clump grows 3 foot tall, red tubular flowers blooms on 5 foot tall stalks

*Perry's Agave (Agave parryi huachucensis) Agavaceae Family*
- Dense rosette forming evergreen, 1-2 foot tall, narrow leaves with toothed margins and large sharp spine and dark pointed tips, pink summer buds

*Golden Barrel (Ferocactus) Cactaceae Family*
- Singular global light green cactus reaching at most 12 inch tall, multiple acute ribs with white flat spines, flowers with a purplish-yellow flower

*Backberg (Eriscyce aurata) Cactaceae Family*
- Singular global dark green and purple cactus, 4-8 inch tall, red flowers in late fall, dry full sun conditions, tubular purple spiky needles

*Santa Rita Prickly Pear (Opuntia violacea Santa Rita) Cactaceae Family*
- Large clump forming cactus, 5-7 foot height, round flat pads, new growth is purple with mature pads an off-green, flowers are yellowish-orange

**Trees**

*Sweet Acacia (Acacia Smallii) Fabaceae Family*
- Multi-stemmed vase shaped tree, rounds as it ages, semi-evergreen 20 foot tall, compound tiny leaflets, bright yellow puffball blooms, very fragrant

*Laurel-Leaf Cocculus (Cocculus Laurifolius) Menispermaceae Family*
- Low sprawling evergreen tree, arching form 25 foot tall, 20 foot spread, very small yellow blooms, black berry fruits

*Chilean Mesquite (Prosopis Chilensis) Fabaceae Family*
- Broad, 30 foot tall semi-evergreen tree, widely spaced narrow leaflets, tan pods and cream colored catkin blooms, gains spikes on stems as it ages

*Evergreen Oak (Quercus Ilex L) Fagaceae Family*
- 50-90 foot tall deciduous tree, full sun, forming brown acorn like seeds

** Shrubs**

*“Little Apple” (Manzanita Incalilies) Arctostaphyllos Family*
- Deciduous 3 foot tall showy shrub, green foliage, white or purple with summer berries, full sun, smooth orange or red bark and twisting branches

*Roman Cassie (Acacia Caven Molina) Fabaceae Family*
- Six to 12 foot tall ornamental shrub, with 1 inch long white thorns, spring blooms are bright yellow 1 inch flowers, attracts honey bees

*Yellow Bird of Paradise (Caesalpinia Gilliesii) Fabaceae Family*
- Large irregular multi-stemmed deciduous shrub, 5-10 foot tall, finely cut ferny leaves, yellow terminal bud clusters with long red stamens

*Little Leaf Cordia (Cordia Parviflora) Boraginaceae Family*
- Evergreen shrub with arching branches, 4-8 foot tall, up to 10 foot wide, small oval leaves with white cluster blooms, grey barked twisting branches

*Maqui (Aristotelia Chilensis Mol. Stuntz) Elaeocarpaceae Family*
- Ten foot tall deciduous shrub, white flowers with edible black berries

*Mexican Grass Tree (Dasylirion Longissimum) Ruscaceae Family*
- Evergreen flowering shrub, 4 to 6 foot tall, long bladed leaves an reach 4 foot long

**Flowers**

*Copihue (Lapageria Rosea Ruiz) Philesiaceae Family*
- Reddish-pink blooms, edible fruits, likes partial shade, water, blooms late summer to fall

*Inca Lilies (Alstroemeria Hookeri Ssp. Recumbens) Alstroemeriaceae Family*
- Red perennial flower, 6 to 10 inches tall, likes arid-dry conditions, full sun

*Quincharmani (Quincharmanium Chilense Mol.) Santalaceae Family*
- Up to 8 inch tall ground creeping perennial flower, yellow flowering terminal clusters, likes dry conditions in full sun

*Renilla (Montiopsis Andicola) Portulacaceae Family*
- Four to 6 inch tall perennial, flat narrow leaves, white-pink blooms, likes water and indirect sun

*Placea Omata (Placea Omata Miers and Lindl) Amaryllidaceae Family*
- 12 inch tall perennial, yellow-white lily shaped blooms, indirect sun to shade

*Ananuca Amarilla (Rhodophiala Bagnoldii) Amaryllidaceae Family*
- Fragrant 15 inch tall perennial, tall stocks have terminal buds, minimal to no foliage, grows in dry, arid condition in full sun; orange and pink variety

---

**Plant List**
a [desert] landscape

plant material

chile

gasses

flame grass_bear grass_jarava ichu

cacti

parrys agave_red yucca_fan palm_grass tree_golden barrell_backeberg_prickly pear

trees

evergreen oak_maqui_sweet acacia

shrubs

manzanita_roman cassie_bird of paradise_little leaf cordia_mesquite

flowers

ananuca amarilla_renilla_copihue_quichamali_inca lilies_ananuca amarilla

[197]
<http://www.chileflora.com/Florachilena/FloraEnglish/PIC_CACTACEAE.php>.
ments  dean r. wayne drummond  h. keith saywers
thank you for your expertise in design as my mentor on this project. your input and guidance throughout this process was very influential on my development as an architect, and i am very thankful for your time and dedication from the very beginning.

critics  sharon s. kuska  nathan s. krug  rumiko handa
guest critics  nathaniel kolbe
consultants  kim a. todd  timothy g. wentz
thank you for your time and your participation in my thesis reviews. all of your input and feedback through the duration of the year was essential for the development and completion of this project.

family and friends
to my family; thank you, you have set a strong foundation for my life on which i can build my hopes and dreams. your love and support will continue to carry me into the next phases of life. dad and mom, thank you for teaching me how to be driven, and creative beyond what i think is possible.

friends; thank you for the unwavering support over the past six years. thank you for the help, feedback, and collaboration through every step of design. your personal creativity will never cease to inspire.

professional
a special thank you to all of my colleagues and professors who have impacted my life added to my experiences over the years.

to dave johnson and all my professional colleagues, thank you for giving me a start, and pushing my creative limits. to mr jon heithold, for teaching me the fundamentals of drawing and design well before i started college.

acknowledgements
“successful design comes from an iterative process encompassing several ideas and then working each through to discover new possibilities”