Designing Affordable Housing out of Shipping Containers for Ciudad Juarez, Mexico

IPRO Faculty Advisors
Michael Glynn
Blake Davis
Peter Beltemacchi

IPRO Team Members
Amy Bourquard
Carl Hart
Chandani Joshi
Joshua Lebak
Man Leung
Michael Lynn
Luke McGuire
Gustavo Mendoza
Brett Monroe
Patrick Park
Jacqueline Schaefer
Yihan Su
Jaquelin Tijerina
Maciej Tusz
Theresa Zappala

IPRO Sponsor
Mr. Brian McCarthy, President: Por Fin Nuestra Casa
1.0 Objectives.

IPRO 339 is focused on providing an affordable housing option for the working poor in Juarez, Mexico. This semester we will research the technologies involved in reusing shipping containers for this housing. We will design a prototype housing unit which will relate to other units in an overall community, with services such as commerce, open spaces for activity, and community centers to support them. We wish to design a housing community that embodies the ideals of humanity, affordability, functionality, opportunity, sustainability, durability, safety, culture, and neighborhood. In order to do this, our team for the Spring Semester has set forth the following objectives:

- Research and understand the users of our product by looking at the social, economic, and physical factors in Juarez, Mexico and in the Maquiladoras where they work.
- Research the most cost efficient and sustainable ways of incorporating plumbing, HVAC, and electricity into the homes.
- Research the structural aspects of building this community.
- Develop a potential site plan and floor plans and sections for the housing units.
- Using our research and designs, develop a proposal for our sponsor, considering the client at hand.

2.0 Results to Date.

1. We had three initial subgroups which consisted of Sociology/Marketing, Design Team, and an Engineering team. When we divided into these subgroups we completed initial research to get a better understanding of what would be required when converting shipping containers into livable spaces. These subgroups yielded initial design ideas that we were able to use in our first design Development Study. This Development Study One had the constraints of using a 100 meter by 100 meter site on either side of a theoretical factory. These two studies produced respective densities of 130 dwelling units and 111 dwelling units.

2. After we complete Development Study One we met with our sponsor Mr. Brian McCarthy, the president of Por Fin Nuestra Casa. We presented both of our solutions and discussed other possible ideas to make each development solution better. After we presented our initial ideas he presented PFNC’s business plan and explained his efforts in developing housing from recycled shipping containers.
3. Our most recent development study is named Development Study Two. Two subgroups, each consisting of half the total project team completed a separate high density study on a theoretical 100 meter by 100 meter site adjacent to a Maquiladora (a factory which imports materials and equipment for assembly and then re-exports them). These subgroups were named “North Subgroup” and “South Subgroup”. The results of the “North” subgroup yielded 512 dwelling units and the “South” subgroup yielded 352 dwelling units on each 100 meter by 100 meter site.

4. Our work so far has yielded the possibility of applying our solution not only to our site in Juarez, Mexico but sites around the world which have a need for employee, volunteer, or relief housing solutions. Research and refinement of our working models are resulting in low cost attractive housing solutions for poor or displaced people in need of quality housing.

5. We have produced two sets of working drawings that include site plans, floor plans, and model configurations, as well as a physical model of each subgroup development solution. In each of our solutions we also have preliminary cost analysis studies with cost projections for single units as well as the entire development. Both hard and soft costs for our site in Juarez Mexico are part of each analysis.

6. We continue to have communications with our valued sponsor Mr. Brian McCarthy PFNC President. His visit to IIT to review our Development Study One reports was useful to our team in outlining guidelines and constraints for our most recent Development Study Two. In depth cost analysis became a key component of the overall development process. He then asked us to examine in depth the cost per unit for our development and to use his constraint of eight thousand dollars per unit to drive our solution.

7. Our current developmental study results will guide the decisions we make in the future by giving us an idea of how to approach problems we still have yet to solve. The results we have now will be taken and then analyzed further to achieve all of our goals of affordable housing from recycled shipping containers. Many of our current successful design decisions will be apparent in our final Development Study.
3.0 Revised Task / Event Schedule.
4.0 Changes in Task Assignments and Designation of Roles and Team Organization.

A. Individual Members and Responsibilities.

1. Name: Amy Bourquard  
   Year: 4th year  
   Major: Materials Science and Engineering  
   Experience, Skills, Strengths: Code of Ethics, preliminary research, participated in the Ethics workshop, worked in initial cost analysis, MEP, and Structural engineering subgroups, worked on Design study – East and North, and is a member of the development engineering sub-group.

2. Name: Carl Hart  
   Year: 3rd year  
   Major: Architectural Engineering  
   Experience, Skills, Strengths: Architectural Intern, AutoCAD, HVAC Analysis/Design Software, Highly Analytical and Detailed  
   Roles: iGroups manager, preliminary research, worked in initial MEP, Space planning, and sociology/marketing subgroups, worked on Design study – East and North, and is a member of the development engineering sub-group.

3. Name: Chandani Joshi  
   Year: 3rd year  
   Major: Molecular Biochemistry and Biophysics/ Pre-medicine  
   Experience, Skills, Strengths: Organization, Management, Research  
   Roles: Project management plan, minute taker, preliminary research on Juarez, worked in initial cost analysis, space planning, and sociology/marketing subgroups, worked on Design study – East and North, and is a member of the development sociology sub-group.

4. Name: Joshua Lebak  
   Year: 4th year  
   Major: Architecture  
   Experience, Skills, Strengths: Urban planning, design, space planning, AutoCAD, 3d Studio Max, Adobe Creative Suite, Model Making, has worked for Lake Forest’s planning office.  
   Roles: preliminary research, worked in initial civil engineering, space planning, and site planning sub-groups, worked on Design study – West and South, and is a member of the development Design sub-group, Midterm Report.
5. **Name: Man Leung**  
   Year: 5th year  
   Major: Civil Engineering  
   Experience, Skills, Strengths: Structural design/analysis to AISC/ASCE Steel Bridge Building Competition 2007, 2008; Non-linearized structural analysis using SAP2000  
   Roles: preliminary research on pre-existing conditions in Juarez, worked in initial civil engineering, structural engineering, and cost analysis sub-groups, worked on Design study – West and South, and is a member of the development engineering sub-group.

6. **Name: Michael Lynn**  
   Year: 5th year  
   Major: Architecture  
   Experience, Skills, Strengths: AutoCAD, adobe illustrator/Photoshop, 3d modeling, model making. Experience in construction and working at architectural firms. I have also worked at CNU, Congress for New Urbanism, doing site planning related research.  
   Roles: preliminary research on Juarez, worked in initial site planning, sociology, and structural engineering sub-groups, worked on Design study – East and North, and is a member of the development Design sub-group.

7. **Name: Luke McGuire**  
   Year: 3rd year  
   Major: Architectural Engineering  
   Experience, Skills, Strengths: IT manager for group of 7 medical clinics (Minnesota Oncology), Software developer for Parametric Technology Corporation, General manager campus radio station, Peer Leadership program developer and facilitator, AutoCAD, MathCAD, Pro/Engineer  
   Roles: Code of Ethics, preliminary research, worked in initial Site planning, Space planning, and structural engineering subgroups, worked on Design study – West and South, and is a member of the development engineering sub-group.

8. **Name: Gustavo Mendoza**  
   Year: 5th year  
   Major: Architecture  
   Experience, Skills, Strengths: AutoCAD, Adobe suite  
   Roles: preliminary research, worked in initial structural engineering, site planning, and sociology sub-groups, worked on Design study – East and North, and is a member of the development Design sub-group.
9. Name: Brett Monroe  
   Year: 4th year  
   Major: Architecture  
   Experience, Skills, Strengths: Problem solving, design, planning, Auto CAD, Adobe Photoshop and Illustrator, 3d Studio Max, Model Making, has worked in several architectural firms in the city of Chicago.  
   Roles: preliminary research, worked in initial site planning, space planning, and MEP sub-groups, worked on Design study – West and South, and is a member of the development Design sub-group, Midterm Report.

10. Name: Patrick Park  
    Year: 4th year  
    Major: Electrical Engineer  
    Experience, Skills, Strengths: AutoCAD, Adobe suite  
    Roles: preliminary research, worked in initial sociology, MEP, and cost analysis sub-groups, worked on Design study – West, and is a member of the development Design sub-group.

11. Name: Jacqueline Schaefer  
    Year: 3rd year  
    Major: Architecture  
    Experience, Skills, Strengths: have worked in 2 architecture offices, cad and some 3dmax skills  
    Roles: project management plan, code of ethics, preliminary research, worked in initial site planning, space planning, and MEP sub-groups, worked on Design study – West, and is a member of the development Design sub-group.

12. Name: Yihan Su  
    Year: 3rd year  
    Major: Applied Mathematics, physics minor  
    Experience, Skills, Strengths: Matlab, a little C++ computer language, 2 languages (Chinese and English), has worked as an accountant in a shipping company.  
    Roles: preliminary research, worked in initial Civil engineering, cost analysis, and structural engineering sub-groups, worked on Design study – West, and is a member of the sociology/marketing sub-group.
13. Name: Jaquelin Tijerina
   Year: 5th year
   Major: Architecture, specialization in landscape architecture
   Experience, Skills, Strengths: AutoCAD, adobe illustrator/Photoshop, 3d modeling, model making, graphic design, bilingual in Spanish/English, visited Mexico, and have worked as an architectural intern, where I have handled projects and dealt with consultants.
   Roles: preliminary research on Juarez, worked in initial space planning, site planning, and sociology/marketing sub-groups, worked on Design study – East, and is a member of the development Design sub-group.

14. Name: Maciej Tus
   Year: 5th year
   Major: Aerospace Engineering and Materials Science, Math minor
   Experience, Skills, Strengths: Worked at NASA for the summer, studied abroad, speak 3 languages, traveled to some poor neighborhoods in my life. Lived in communist Poland so understand the mentality of some of these projects, open mind
   Roles: time sheet collector/summarizer, preliminary research on materials, worked in initial MEP, Structural, and cost analysis sub-groups, worked on Design study – East, and is a member of the development engineering sub-group.

15. Name: Theresa Zappala
   Year: 3rd
   Major: Architecture
   Experience, Skills, Strengths: Project leader, group leader, computer skills (Adobe suite, Microsoft Office suite, CAD, VIZ), on time, dedicated, able to see the whole picture and focus on many different parts of a project at once, worked as an intern for two different firms
   Roles: project management plan, preliminary research, worked in initial site planning, space planning, and sociology sub-groups, worked on Design study – West and South, and is a member of the development sociology/marketing subgroup.
B. Sub-groups.

1. **Sociology/Marketing**: Defining the economic scope of our project and our clients (both the corporation buying the project and the families buying the units). Defining the cultural needs of the clients, in order to work their habits into the design. Researching social patterns that affect design. Researching the best way to present the idea to a client. Preparation of building/construction cost analysis.
   Sub-group leader: Chandani Joshi

2. **Design Team**: Using the sponsor’s initial requirements as a starting point, preparing individual unit floor plans and a site arrangement conducive to fostering a community atmosphere without drastically changing the cultural needs of the client.
   Sub-group leader: Jacquelin Tijerina

3. **Engineering Team**: Preparing an analysis of the best and most cost effective passive heating and cooling systems, any supplementary mechanical systems, plumbing systems, and any auxiliary structural systems needed to support the Design Team’s plans.
   Sub-group leader: Luke McGuire

4. **Developmental Study Group One, East**: Preparing developmental studies which analyze a typical 100 meter by 100 meter site. Analyzing conditions and constraints that effect design decisions. Research topics which address design intents within the scope of the project. There are no designated sub-group leaders for the individual developmental studies.

5. **Developmental Study Group One, West**: Preparing developmental studies which analyze a typical 100 meter by 100 meter site. Analyzing conditions and constraints that effect design decisions. Research topics which address design intents within the scope of the project. There are no designated sub-group leaders for the individual developmental studies.

6. **Developmental Study Group Two, North**: Preparing developmental studies which analyze a typical 100 meter by 100 meter site with a high density solution (higher than development study one) which has a typical building height of four stories. Analyzing conditions and constraints that effect design decisions. Research topics which address design intents within the scope of the project. There are no designated sub-group leaders for the individual developmental studies.

7. **Developmental Study Group Two, South**: Preparing developmental studies which analyze a typical 100 meter by 100 meter site with a high density solution (higher than development study one) which has a typical building height of three stories. Analyzing conditions and constraints that effect design decisions. Research topics which address design intents within the scope of the project. There are no designated sub-group leaders for the individual developmental studies.
Sub-group Name | Sociology/Marketing | Design Team | Engineering Team
---|---|---|---
Sub-group Leader | Chandani Joshi | Jacquelin Tijerina | Luke McGuire
Group Members | Theresa Zappala | Jacqueline Schaefer | Carl Hart
 | Yihan Su | Michael Lynn | Man Leung
 | Patrick Park | Joshua Lebak | Maciej Tusz
 | Michael Glynn (Prof) | Gustavo Mendoza | Amy Bourquard
 | Blake Davis (Prof) | Brett Monroe | Michael Glynn (Prof)
 | Michael Glynn (Prof) | Blake Davis (Prof)

Sub-group Name | Development Study Group One East & Group Two North | Development Study Group One West & Group Two South
---|---|---
 | Amy Bourquard | Joshua Lebak
 | Carl Hart | Man Leung
 | Chandani Joshi | Luke McGuire
 | Michael Lynn | Brett Monroe
 | Gustavo Mendoza | Patrick Park
 | Jaqueline Tijerina | Jaquelin Schaefer
 | Maciej Tusz | Yihan Su
 | | Theresa Zappala

C. Roles.

1. Meeting Roles
   i. Minute Taker: Chandani Joshi
   ii. Agenda Maker: The professor is the agenda maker for this IPRO.
   iii. Time Keeper: The professor is time keeper for this IPRO.

2. Status Roles
   i. Weekly Timesheet Collector/ Summarizer: Maciej Tusz
   ii. Master Schedule Maker: Chandani Joshi
   iii. iGROUPS: Carl Hart

D. Changes From Project Plan.

The major change from the Project Plan was the addition of two more sub-groups to develop higher density solutions simultaneously. These two sub-groups consisted of various members from each already established sub-group. The purpose of both developmental studies was to take a 100 meter by 100 meter site and come up with two solutions within the same constraints i.e. site configuration, floor plans, density, and amenities. Each group consists of members from each previous sub-groups so all disciplines are present to develop two complete ideas from varying backgrounds. The minor change involves one team member’s
withdrawal from the IPRO, and therefore he has been removed from our sub-
groups as well as task assignments.

5.0 Barriers and Obstacles.

A. **Obstacles Encountered.**
Obstacle One: The initial brainstorming of the project, which included
site layout and plan design, was one of the biggest obstacles to resolve. A
group member may have wanted their idea to ultimately be used over
another member’s idea because they may have thought it was the best plan
for the application. There were many great ideas between group members,
but unfortunately, not everything could be implemented.
Obstacle Two: The outcome and the overall reaction to the finished
product. We asked ourselves a few question: How the residents in Ciudad
Juarez would react to the shipping container as an environment for living
and how the space would actually be inhabited.

B. **Obstacle Resolution.**
Obstacle One: In order to advance on final decisions, the group had to
make a number of compromises. It was especially hard when one does not
offer full support in someone else’s idea. To aid in the process, we took
in account input on the disliked and liked ideas. If their idea wasn’t
chosen, it wasn’t completely disregarded or looked over. Their idea was
either built upon or modified certain ways to create the best solution for
the application.
Obstacle Two: To overcome this obstacle, we did some research of the
current conditions in Ciudad Juarez that the workers are living in. They
are living in some sort of shanty town by the factory. Their current living
conditions don’t have any permanent structure, only implemented scraps
that could be considered garbage to us. We thought if any new type of
innovative and affordable housing was introduced to the area, it would
undoubtedly be an improvement over anything they have encountered.

C. **Remaining Barriers / Obstacles.**
Barrier One: A big barrier that we are facing is the ability to create an
innovative, sustainable design to meet our client’s budget per container.
Some ideas wanted to stray away from a simple stacking, causing us to
have to add more supports around the container. Along with abnormal
layout, minimizing stairs in the overall site was a concern, in forms of
accessibility and egress.
Obstacle One: Clashing of majors in the IPRO. Certain people may think
they are in the IPRO to fulfill their one specialty duty. This greatly limits
how the problem could be solved by having only one person working on
separate problems.
D. **Team Plans Regarding Barriers / Obstacles.**

   Proposed Plan-Barrier One: When thinking of the final design, we want to minimize the amount of additions, unnecessary components, and fabrication to the project in order to help keep costs down. Also, we can consider buying certain appliances or materials in bulk to help save costs and to keep under budget. We can research suppliers and compare prices on their products.

   Proposed Plan-Obstacle One: Someone of a different specialization has a different outlook on the same problem. They can aid in the final decision by putting the problem in a different perspective. It makes problem solving easier to tackle it from multiple angles from multiple people than have one person have the same perception.