IPRO 339A '08 FINAL REPORT

Designing Affordable Housing out of Shipping Containers for Chicago, IL

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1.0 Abstract

IPRO 339 A (Chicago group) is focused on repurposing shipping containers into affordable housing for Chicago, IL. This project is an extension of IPRO 339 (Juarez Group) which started in spring of 2008, and continues to design housing for under paid workers, or Maquiladoras, who relocate from rural Mexico to Juarez to work in the area's factories.

IPRO Chicago inherits the core of the Juarez Group's vision to design safe, well thought out communities, but with Chicago in mind. At its heart Chicago group strives to design a comfortable space for every day urban life, one with all the essential amenities, and one that can be run on a modest budget. Our approach takes into consideration factors particular to Chicago such as climate, lot size, city codes, energy efficiency, aesthetics and sociological considerations.

Our initial goal is to eventually construct a number of our repurposed container homes in Chicago neighborhoods and have them occupied by families. Once we are successful, we intend to use the design, as well as a systematic approach to constructing the homes, to implement our low cost housing solution to other parts Chicago, and eventually to other American cities that suffer a shortage of affordable housing. We also intend to offer our design and method as a permanent housing solution for victims of natural disasters such as hurricanes, flooding, and earthquakes. Our secondary goal is to use the research and design methods from previous semesters as a basis for a housing proposal for the 2016 Olympics.

2.0 Background

The Chicago group is an extension of IPRO 339, started in spring of 2008. IPRO 339 strives to design affordable homes for workers in Juarez, Mexico, and its first iteration was underwritten by Mr. Brian McCarthy, President of PFNC Global Communities in Corrales, New Mexico.

While IPRO 339A uses the same idea of repurposing shipping containers into affordable housing, it does so by taking into consideration factors unique to Chicago. First off, Chicago is a city known for its neighborhoods. When we sat down to design the plans for our home, we thought closely about the dynamics of our city's neighborhoods. Chicago neighborhoods are legendary: they're sturdy; they have a dependable and solid look and feel about them. We wanted our home to be distinctive, modern, yet in the same traditional style. To achieve this we focused on a design with an exterior envelope that included brick.

We discussed what affordable housing would mean to any Chicago neighborhood. Like many American cities, Chicago's neighborhoods are undergoing a

transformation. New development has become commonplace, and some neighborhoods, notably on the near south side, are losing long time residents. Most of these residents are retired; others live near the poverty line and can no longer afford the upkeep and taxes on the property they have occupied for decades. Because we believe that the strength and character of a neighborhood hinges on long time residents to maintain the equilibrium of culture, and ultimately the prosperity that results from its vibrancy, we were motivated to create homes that long time residents could afford, so that they could continue to contribute to their communities.

The local economy benefits from strong neighborhoods. Having long time residents in safe, efficiently designed homes, means that a neighborhood is stable. And if a neighborhood has permanence, the trust between the people in a community becomes solid. The result will invest in it, setting up retail stores and services.

In our belief that affordable housing strengthens communities, and that strong communities afford their participants with a sense of trust, we considered ethical implications as we made our design decisions. For example, we decided to prefabricate our homes so they could be assembled quickly on our lots. After this decision was made, we began to consider where the prefabrication work might be done. Because having a job is essential to a person's livelihood, especially if that person has a family to support, we thought it preferable to have the work done locally so that unemployed skilled laborers might have the opportunity to earn a paycheck so that they might support their families.

What is unique to IPRO 339 A Fall Semester '08 is to use the research and design proposals from previous semesters as a basis for a proposal for the 2016 Olympics. Very few Olympic cities have made a profit from the Olympics. Taxpayer's money is usually a major part of funding the Olympic Games due to the need to build housing and sporting facilities. In a time where our country is in economic crisis it is critical to find the most economical as well as innovative building solutions so that Chicago can be seen as a competitive host for the 2016 Olympics. The majority of housing is not for Olympic athletes but instead for the media personnel and workers responsible for holding the games. We feel that using shipping container's as temporary housing for these workers is not only innovative but also an economical solution for housing media personnel. These containers can be used for the few weeks the Olympics are held and then repurposed and used in our permanent housing solution for Chicago communities. By doing so we limit the money that is usually needed to build these housing facilities as well as limit waste of building materials. It also defeats the worry of selling these facilities as condos in an uncertain real estate market.

3.0 Objectives

The objective of IPRO 339 is to provide an affordable housing option for the people of Chicago. This semester's IPRO concentrated on not only continuing to design affordable housing for Chicago but also using this design as a basis for a temporary housing proposal for the 2016 Olympics. Our focus is to use shipping containers as housing for the 2016 media personnel and then use these containers in our permanent housing designs for communities of Chicago after the Olympics have ended.

The objectives for this section of IPRO 339 A:

To continue to develop site plans, floor plans, and continue to innovate solutions and options from the spring 2008 semester, the first semester of the project.

To produce affordable, vernacular housing for residents. Shipping containers are inexpensive and have a solid structure but are generally not attractive and are difficult to heat and cool. Objective: come up with an attractive design and research economical heating and cooling solutions.

To research low-cost interior furnishings from the RV/mobile home industries located in Indiana. Using mobile home fixtures will speed up the construction of our homes, and reduce on site construction costs.

To research prefabrication options. If a container home can be brought on to the site with most of its elements assembled, the exterior can be added immediately, and the home can assume the appearance of a Chicago style home. A quick metamorphosis will minimize the stigma of the home made from a shipping container and will elevate any controversy about them.

To incorporate environmentally friendly technologies into the design as well as incorporate the most cost efficient methods to bring sustainable plumbing, HVAC and electricity into the homes.

To consider the ethical implications of our design decisions at each stage of development. Be certain that our prototype embodies the ideals of affordability, functionality, opportunity, sustainability, durability, safety in any neighborhood. The design must encourage and promote a sense of community.

To research all structural aspects of the shipping containers so as to limit the addition of expensive structural components needed for building.

To start researching and contacting vendors of products necessary for building our design proposal.

To create a presentation to propose a temporary housing design to the 2016 Olympic Committee.

To propose our permanent housing design to the Alderman with the goal of obtaining a Chicago lot to construct said design.

4.0 Methodology

Each Sub-group was assigned a list of challenges. Research was paramount to our decision making, the findings to be used to include solutions that would move our objective of affordable housing in Chicago one large step forward. Each sub-group was responsible for organizing, documenting, and incorporating the research materials, and presenting to the group the solutions in the form of drawings and power point presentations in our weekly class meeting. All of the groups collaborated on the final deliverables presented to the judges on IPRO Day, December 5th, 2008.

At the beginning of the fall semester 2008, the Chicago group decided upon their objectives and divided into four teams. The teams focused on issues related to energy, design, infrastructure, and the exterior envelope.

To achieve the overall objectives of IPRO 339, for both the Chicago and Juarez groups, during the semester each team worked with their counterparts in the other IPRO section to solve a list of specific challenges. These challenges were:

Design
To visualize the shipping containers as homes. They were to come up with floor plans laid out with families and individuals in mind. They designed incorporating zoning requirements for a Chicago lot.

Exterior Envelope
To address the aesthetics problem faced repurposing shipping containers into homes. It was a priority to solve problems connected with making our home "distinctively Chicago," i. e., brick exteriors and making them fit on a common Chicago lot which is 25 by 125 feet. Also fire codes and building codes were incorporating in the final exterior envelope.

Energy
To designing efficient energy systems. They were to focus on keeping our home warm in winter and cool in the summer, solar energy options, and methods of saving and reusing energy.
Infrastructure

Infrastructure
To design electrical and plumbing systems for our home.

Work Breakdown Structure

Chicago Team
Energy Subgroup
*** * Hrs. represents time spent per each member on respective task**

Id	Task	Start	End	*Hrs.	Team members
1	**Research phase I**				
1.1	Solar Power	08/29/08	09/09/08	8.5	Yu Cheung
1.2	Solar Products	09/12/08	09/12/08	2.0	Yu Cheung
1.3	Ground heat	09/18/08	09/18/08	2-0	Yu Cheung
1.4	Zero energy house	09/19/08	09/19/08	2.5	Yu Cheung
1.5	Heat pumps	09/26/08	09/26/08	1.5	Yu Cheung
1.6	Heat exchangers	10/03/08	10/03/08	1.5	Yu Cheung
1.7	Micro CHP	10/10/08	10/10/08	1.0	Yu Cheung
2	**Research phase II**				
2.1	Central cooling system	10/24/08	10/25/08	3.0	Yu Cheung
2.2	Energy modeling	10/30/08	10/30/08	3.0	Yu Cheung
2.3	How to save more energy	11/01/08	11/01/08	1.0	Yu Cheung
3	Software Modeling				
3.1	Software energy 10	11/05/08	11/07/08	2.0	Yu Cheung
3.2	Energy simulation model	11/08/08	11/08/08	1.0	Yu Cheung
3.3	Energy calculations	11/14/08	11/14/08	7.5	Yu Cheung
3.4	Preparing and creating energy final report	11/14/08	11/22/08	7.0	Yu Cheung

Infrastructure Subgroup
*** Hrs. represents time spent per each member on respective task**

Id	Task	Start	End	*Hrs.	Team members
1	**Research phase I**				
1.1	Average yearly waterfall	08/29/08	08/29/08	3.0	Rosa
1.2	Envirolet toilet and accessories	09/11/08	09/12/08	5.0	Rosa
1.3	Radiant floors	09/23/08	09/23/08	3.0	Rosa-Victor
1.4	Tandem locks	10/02/08	10/02/08	2.0	Rosa-Victor
1.5	Grey water storage systems	10/08/08	10/10/08	5.5	Rosa

2	**Research phase II**				
2.1	Water tanks systems	10/31/08	10/31/08	5.5	Rosa
2.2	Water tank details	11/14/08	11/20/08	7.0	Rosa
2.3	Tandem locks	11/20/08	11/20/08	1.0	Victor
3.1	Finalizing water tank details	11/21/08	11/25/08	6.5	Rosa

Exterior Envelope Subgroup

*** Hrs. represents time spent per each member on respective task**

Id	Task	Start	End	*Hrs.	Team members
1	**Research phase I**				
1.1	Masonry facade	08/27/08	08/27/08	2.0	Lauren
1.2	Real state and rental prices	09/01/08	09/04/08	3.5	Karen
1.3	Shading options	09/01/08	09/01/08	3.0	Lauren
1.4	Insulating options	09/05/08	09/23/08	4.0	Lauren
1.5	Fire codes	09/08/08	09/12/08	6.5	Karen
1.6	Building Codes	09/09/08	09/19/08	10.0	Karen
2	**Research phase II**				
2.1	Tie back options	10/02/08	10/02/08	2.0	Lauren
2.2	Steel building units	10/08/08	10/08/08	2.5	Karen
2.3	Ceramic insulating paint	10/22/08	10/22/08	2.0	Karen
2.4	Grout options	10/23/08	10/23/08	1.5	Lauren
2.5	Tandem-lock system	11/03/08	11/03/08	2.5	Adriana
2.6	Parapet wall	11/12/08	11/14/08	2.0	Lauren-Adriana-Karen
2.7	Roof plan calculations	11/18/08	11/18/08	1.0	Adriana
3	Creating and revising exterior detail	09/15/08	11/30/08	20	Adriana
4	Creating model and renderings	10/10/08	11/29/08	11	Lauren

Housing Design Subgroup

*** Hrs. represents time spent per each member on respective task**

Id	Task	Start	End	*Hrs.	Team members
1	**Research phase I**				
1.1	Review of previous semester work	08/27/08	08/27/08	3	Fabian, Mariusz

1.2	Site visits and site research	09/01/08	09/04/08	4	Anton, Fabian, Mariusz
1.3	Olympic Village research	09/01/08	09/01/08	2	Michael
1.4	Preliminary floor plans and site study	09/05/08	09/23/08	6	Mariusz
1.5	Building materials pricing research	09/05/08	09/23/08	6	Christopher
2	**Research phase II**				
2.1	Building codes research	10/02/08	10/02/08	4	Mariusz
2.2	Floor plans development	10/08/08	10/08/08	3.5	Anton, Fabian, Mariusz, Michael
2.3	Preliminary elevations	10/22/08	10/22/08	4	Christopher, Fabian, Michael,
2.4	Multi unit floor plan development	10/23/08	10/23/08	5	Christopher, Fabian, Mariusz, Michael
2.5	Multi unit elevation options and corrections	11/03/08	11/03/08	4	Fabian
2.6	Alternative design concept	11/12/08	11/14/08	6	Phil
3	Multi unit final elevations	11/03/08	11/03/08	6	Fabian
4	Multi unit final floor plans	11/12/08	11/14/08	5	Mariusz

IPRO Deliverables

*** Hrs. represents time spent per each member on respective task**

Id	Task	Start	End	*Hrs.	Team members
1	**First Project Plan**				
1.1	Creating and updating	09/08/08	09/09/08	6.0	Christopher
1.2	Outlining	09/09/08	09/09/08	2.5	Michael-Anton
2	**Midterm Presentation**				
2.1	Creating power point-presenters	10/09/08	10/11/08	5.0	Rosa-Adriana-Victor-Fabian
2.2	Renderings	10/09/08	10/09/08	5.0	Lauren
3	**Final Deliverables**				
3.1	Abstract/Brochure	11/26/08	11/26/08	6.0	Phillip
3.2	Poster	11/28/08	11/28/08	10	Christopher
3.4	Final Project Plan-abstract-objectives-background	11/29/08	11/29/08	2.0	Lauren
	Final Project Plan - Methodology-Work breakdown-structure-team assignments-results-	11/29/08	12/06/08	11	Karen

	obstacles-recommendation-resources-acknowledgement				
3.5	Final Presentation				
	Power point-Presenters	11/29/08	11/30/08	6.0	Adriana-Victor-Phillip
	Final plans-elevations for power point and posters	11/28/08	11/28/08	4.0	Fabian-Mariusz

5.0 Project Budget

Item	Price	QTY	Price	Purpose
Printing	$5.00	10	$50.00	Printing of renderings, floor plans, site plans for in class presentations
IPRO day	$125.00	2	$250.00	Poster and Presentation materials (Including models)
TOTAL:			**$300.00**	

6.0 Team Structure and Assignments

Name	Major, year	Skills and Strengths	Team	Assignments
Rosa Villalpando	Architecture, 5th year	Auto Cad, 3d Max, Photoshop, Illustrator,	Chicago team, Infrastructure	research, water tank detail, midterm presentation
Christopher Spedale	Architecture, 4th year	Auto Cad, Photoshop, 3D Max, Illustrator	Chicago team, Housing Design	midterm project plan, poster, design plans
Adriana Rios	Architecture, 5th year	Auto Cad, Rhino, 3d Max, Revit, Adobe, Corel Paint, Excel,	Chicago team, Exterior Envelope	cladding research, developing details, midterm and final presentation

Lauren Mordecai	Architecture, 5th year	Auto Cad, 3d Max, worked in 2 architectural firms, experience in rederings and animation	Chicago team, Exterior Envelope	exterior envelope research, renderings
Victor Mitchell	International Business, 4th year	Project leading, Visions, Design, Auto Cad, detail oriented, public speaking	Chicago team, Infrastructure	research, midterm and final presentation
Anton Llakmani	Arch. Eng. 3rd year	Auto Cad, Math Cad, SAP2000 highly analytical, detailed oriented	Chicago team, Housing Design	worked on design study
Mariusz Klemens	Architecture, 4th year	3D software, Auto Cad, Graphic Design, Architectural practice	Chicago team, Housing Design	designing and developing plans
Phillip Haywood	Architecture, 4th year	Auto Cad, Photoshop, Illustrator, 3D Max	Chicago team, Housing Design	developing plans, brochure
Michael Cullen	Architecture, 4th year	Auto Cad, Photoshop, Illustrator, 3D Max	Chicago team, Housing Design	developing section, elevations
Fabian Escobar	Architecture, 4th year	Auto Cad, Photoshop, 3D Max, Illustrator	Chicago team, Housing Design	designing and developing plans
Yu Cheung	Mechanical Engineer, 3rd year	Data Calculation, Result analysis, solve problems by Non-traditional way, new power source for vehicles.	Chicago team, Energy	research, design energy system for the building
Karen Rivas	Architecture, 5th year	Auto Cad, Photoshop, 3D Max, Illustrator, Excel, Word	Chicago team, Exterior Envelope	cladding research, building codes, project plan

Group Teams

Sub-group Name	**Juarez, Mexico**	**Chicago, Illinois**
Group Members	Shreyas Dole	Rosa Villalpando
	Joe Peroni	Christopher Spedale
	Heather Olson	Adriana Rios

	Benjamin O'neil	Karen Rivas
	Jeremy Moore	Lauren Mordecai
	Haim Eliyahu	Victor Mitchell
		Anton Llakmani
		Mariusz Klemens
		Phillip Haywood
		Fabian Escobar
		Yu Cheung
		Michael Cullen
	Michael Glynn (Prof)	Blake Davis (Prof)

Organization of the Teams

Sub-group Name	Energy	Infrastructure	Exterior Envelope	Housing Design
Group Members	Yu Cheung	Rosa Villalpando	Adriana Rios	Christopher Spedale
	Jeremy Moore	Victor Mitchell	Lauren Mordecai	Fabian Escobar
		Joe Peroni	Karen Rivas	Mariusz Klemens
			Shreyas Shrikar Dole	Anton Llakmani
			Haim Eliyahu	Phillip Haywood
				Michael Cullen
				Benjamin O'Neil
				Heather Olson

7.0 Results

Our teams were successful in moving IPRO 339 toward its goal of repurposing shipping containers into affordable housing for Chicago.

Reported results:

The energy group developed a system that includes a combined heat and power system. This will provide a Heating System, Cooling System, Electric power appliances and Hot Water System. The cooling system is Absorptive Cooling System. This uses a pressure theory to get a low boiling point. The working solution takes heat away when it boils. We save energy by using waste heat. A gas generator could be used to provide electricity for the entire building. For individual units a hybrid engine, one similar to a car engine, could be used. The group also concluded that the heating load value for Chicago reflects the necessity of effective insulation which would retain heat and energy.

Structurally we found that any connections or attachments to the container should only be made on the frame of the container. Nothing should be attached to the corrugation itself, as it does not have enough strength to sustain lateral loading. Any cuts being made for doors (as well as windows, preferably) should be made away from the center of span lengths (half the length of the container where no reinforcements have been made, or halfway between supports where they have been added) because this is where the largest moment forces will develop in the structure. All cuts being made in the corrugation should be reinforced with a frame. This should be made from a minimum of wooden 2”x4”s. The lowest container should rest on a footer beam that spans the entire length. This will help to provided greater stability to the structure, and eliminate sag between the footings. Recommended section: W12x40 In areas where large sections of corrugation (15’+) must be removed, the roof frame section should be reinforced with a header beam. Recommended section: W5x19.

Successful floorplans for a 53’ container could easily incorporate a typical 3 story building which will have parking spaces on the first floor and 2 and 1 bedrooms units with an accessible bathroom, kitchen, living room space, a utility room and a dining space. It is economically feasible to provide each kitchen with a stove, a sink, wall cabinets, a refrigerator and counter space. The idea is to have the kitchen open to the living space or dining space in the unit. Windows in each bedroom will substantially offset energy costs.

A pier foundation system rather than continuous footing system will save on the cost of concrete. It is also feasible to use blown cellulose made mostly from recycled shredded newspaper and mixed with a variety of chemicals (up to 25% by weight) to reduce costs and save energy. Tandem locks were used to connect the shipping steel units.

A traditional brick wall system can be constructed cheaply; we will be able to use local materials and union labor. Using brick we will be successful in blending our homes in with the surrounding Chicago homes.

8.0 Obstacles

The enormity of our task was huge concern. Because over the last 10 years, developers have had the upper hand in forming the modern day Chicago cityscape, it seems as if designing affordable housing is a feudal endeavor. We overcame this obstacle by believing in our mission. Another obstacle was to come up with ideas that would make our distinctively Chicago and to address acoustical problems with working with stacked metal structure.

A huge obstacle was to get people involved in this project. We tried several times to get a person from the Masonry Institute to help us with the exterior wall detail. However after many attempt that person was not able to come to our class. We overcame this by investing twice the time to checking building and fire codes and considering Tandem locks to connect the steel containers. Oddly one problem IPRO Chicago had is that it's such an exciting project sometimes there were numerous solutions to a single problem. Choosing the right one was sometimes at tough especially when an economical solution is a priority. We also did not have the time an opportunity to get people from the RV companies to get involved in the project. Infrastructure sub-group did a lot of research to compensate for this.

9.0 Recommendations

IPRO 339 Chicago recommends further development of the concept of repurposing shipping containers to affordable housing. Transforming shipping containers into affordable housing is the solution to the shortage of affordable housing in Chicago, as well as other urban centers.

Shipping containers are abundant, can be purchased cheaply, and can provide a solid core for a home. As our groups thought through the solutions to the problems facing our project, we discovered that collectively we were able to come up with solid design ideas, that can in time be used to build homes for Chicago residents. With safe housing stock our neighborhoods flourish. And, when our neighborhoods are healthy, so is the cultural and economic life of our home, Chicago.

We strongly recommend that future groups begin preparations for assembling a model and come up with a strategy to sell the idea to community leaders and city government. It is a great opportunity for future IPRO groups to get the Chicago community aware in case the 2016 Olympics take place here in this city. Also, the group should continue a close communication with the alderman of the 3rd ward to possible have a lot where this idea can be implemented.

10.0 Resources

Important research materials.


Energy Calculation.ppt


ENERGY_1004_IPRO 339.pdf


Energy 10 Sample-1.ppt

11.0 Acknowledgements

We would like to thank our Professors Michael Glynn and Blake Davis for their expert opinions and suggestions throughout the project. We know that this project is crucial to the future of affordable housing in Chicago and wish them much success.