

Innovative Container Design

An IIT Interprofessional Project



Prepared by:
Fall 2009 IPRO 339 Project Team
The Interprofessional Projects Program
Illinois Institute of Technology
Chicago, Illinois

Michael Glynn, IPRO Instructor
Blake Davis, IPRO Instructor

The Interprofessional Projects (IPRO®) Program at Illinois Institute of Technology

An emphasis on multidisciplinary education and cross-functional teams has become pervasive in education and the workplace. IIT offers an innovative and comprehensive approach to providing students with a real-world project-based experience—the integration of interprofessional perspectives in a student team environment. Developed at IIT in 1995, the IPRO program consists of student teams from the sophomore through graduate levels, representing the breadth of the university’s disciplines and professional programs. Projects crystallize over a one- or multi-semester period through collaborations with sponsoring corporations, nonprofit groups, government agencies, and entrepreneurs. IPRO team projects reflect a panorama of workplace challenges, encompassing research, design and process improvement, service learning, the international realm, and entrepreneurship. (Refer to <http://ipro.iit.edu> for information.)

The *Innovative Container Design IPRO 339* team project represents one of 40 IPRO team projects for the fall 2009 semester that involved over 500 students, 40+ instructors and 30+ sponsors, community partners and other collaborating organizations.

TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	3
1. PURPOSE & OBJECTIVES.....	4
2. ORGANIZATION & APPROACH.....	7
3. ANALYSIS & FINDINGS.....	13
4. CONCLUSIONS & RECOMMENDATIONS.....	16

APPENDIX

1. LIST OF TEAM MEMBERS
2. TEAM EXPENSE BUDGET
3. WORKING LIST OF POTENTIAL CONTACTS
4. RAW DATA

Executive Summary

This report summarizes the work of a multidisciplinary team of students from the Interprofessional Projects Program (IPRO) at the Illinois Institute of Technology. The work that is compiled in this document was conducted during the fall 2009 semester, from August through December.

IPRO 339 focused on bringing innovative shipping container homes to the neighborhoods of Chicago. Obtaining affordable housing is a serious problem for many Chicago residents. Therefore, this IPRO aimed to alleviate the problem by introducing affordable and sustainable housing options derived from novel ideas of converting shipping containers into livable housing units. With this solution there were several inherent challenges that had to be addressed. By tackling these issues head on, this IPRO has been able to create a housing solution that not only would fit in well with its surrounding context, but do so in a more affordable way.

The IPRO team began its work by building upon the ideas and work of the previous semesters. Initially the focus of the team was to create an economical and environmentally friendly solution for temporary Olympic housing. The plan was innovative, as it sought forward thinking and asked City Planners to consider the 2016 Olympic Village as a “temporary community” assembled solely for the Olympic athletes, and then disassembled and reused. The plan was also affordable with current cost estimates a fraction of those outlined and published by the 2016 Olympic Committee. It would utilize thousands of empty shipping containers stockpiled around the Chicago area by converting them to provide a cost effective alternative to traditional housing units. Since the outcome of the International Olympic Committee’s decision for the host of the 2016 games did not fall in Chicago’s favor, the IPRO team shifted its focus to creating affordable housing for Chicago neighborhoods and began to tackle a new topic of creating affordable graduate housing for the Illinois Institute of Technology.

Purpose & Objectives

I PRO 339 has taken on the task of addressing two issues head on. First and foremost is the issue of the lack of affordable homes in the Chicago area and second is the vast amount of shipping containers that fill up lots all over the United States. So how can one tackle these two problems at once? That is where our team has come up with a solution.

The ISBU, otherwise known as shipping containers, are standardized shipping boxes that are responsible for the transportation of our worldwide economy. Strangely enough, it is more expensive to ship an empty container than it is to build a new one, and as a result over 700,000 containers sit in intermodal yards, stuck and unused. Here is where the opportunity lies to alleviate this problem. Excess containers can be re-purposed to serve as the main construction element in the design of new Chicago homes. They are ideal for many reasons; they are exceptionally strong, modular, and relatively inexpensive when compared to traditional methods of construction. Using containers as modules would allow for houses to be finished off-site, and be put together in only two to three weeks. This would save on-site construction time and make it easier to work through cold months. In these ways it would be more cost effective than conventional construction for both the developer and owner.



Therefore the shipping container design that this I PRO team is proposing can and should be implemented in Chicago. This project first began by looking to create an affordable housing solution that was both sustainable and progressive. That vision has grown over the past two years into a strong belief

that shipping container dwellings should become a part of Chicago neighborhoods, enabling more families to become home-owners.

Our mission was not only to design, but to actually construct a full-scale model of the affordable housing design, that can be experienced, educating and raising awareness about alternative, and cost efficient ways of designing temporary and permanent housing. The belief is that the future of sustainability in modern construction could be further enhanced. Therefore, the presented design is intended to be aesthetically appealing, practical, and cost efficient to individuals for diverse backgrounds. The prototype for efficient permanent housing would target the entry level consumer. Based on their inherent structural integrity, shipping containers are the building blocks for the realized full scale model.

The City of Chicago and its officials have been slow to develop permanent housing for people in need, partially due to the economic crisis facing us these days, resulting in many individuals being left homeless. The paucity of affordable housing solutions available for the residents of the City of Chicago has forced numerous people to either relocate or to move to the streets. In order to ensure that our attempt to develop affordable homes does not face the same fate as numerous others projects have in the past, we must take extra care in making sure that our homes fit into the typical Chicago lot and that they resemble the architecture and character of neighboring homes in addition to creating a higher quality of affordable housing for the local residents of Chicago. The following are a list of objectives that the IPRO team has set forth to accomplish this semester.

- Research previous uses of shipping containers for purpose of building housing units.
- Build upon previous semester's IPRO proposal to further develop the affordable housing solution.
- Explore possible technical solutions for structure of façade and ensure successful implementation into Chicago's urban environment.
- Ensure civic and handicap accessibility in housing solution.

- Research the most cost efficient and sustainable ways of incorporating plumbing, HVAC, and electricity into these units.
- Explore possibilities aimed to increase energy efficiency of the housing in cost efficient ways.
- Compile an itemized list of required materials and components.
- Compile an estimated amount of labor hours that will be required by out of house sources (such as union workers).
- Create a budget.
- Implement a Marketing Plan.
- Increase publicity for the IPRO by creating a web page, and using other social networking devices, such as Facebook or Twitter.
- Create awareness about our IPRO project in the IIT community and in the entire Chicago-land area.
- Write and publish articles about our IPRO in the IIT Tech News, IIT Today and other possible Chicago publications.
- Promote our IPRO design on public radio and TV.
- Interact with prospective home buyers to get their personal views of what is accepted vernacular for a new home.
- Gain the support of the Aldermen involved, and the Chicago Housing Authority.
- Create a presentation to present to city officials including 3-D rendered models which will be integrated into our marketing plan.
- Create relations with potential sponsors and funding options to build our life-size model.
- Verify and receive final permission for construction on site by IIT.
- Acquire all materials needed for construction of model.
- Build a life-size prototype of our design.
- Use our prototype to promote the implementation of our solution and create awareness about alternative construction methods.

Organization & Approach

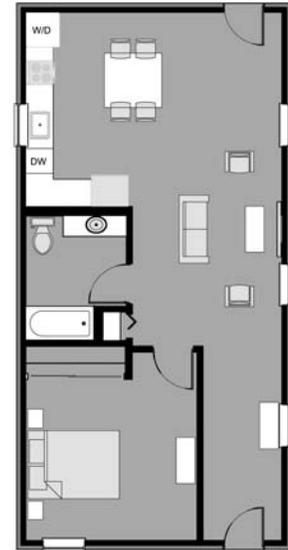
At the beginning of the semester the students of IPRO 339 closely examined and evaluated the work of the previous semesters to get a better understanding of what approach should be taken. The team was then broken down into four sub-groups; Full-scale model, Olympic village design, Affordable Housing Design, and Presentation & Marketing. Since the Olympic decision did not fall into Chicago's favor, the members of the Olympic Village sub-group were then redistributed to the remaining teams based on their strengths and the needs of the other sub-groups.



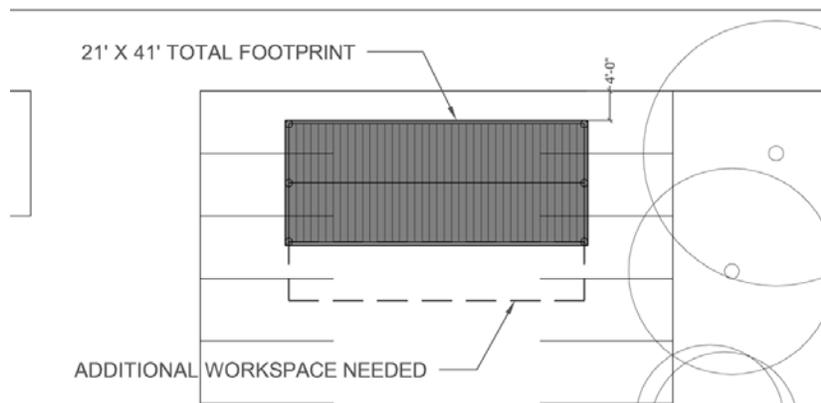
The Full Scale Model group worked to create and construct the site plan for the full scale model that would stimulate support and exposure in the community as well city-wide. The full scale model would be used to showcase the advantages to this method of constructing houses and serve as a tangible example of the soundness of this idea.



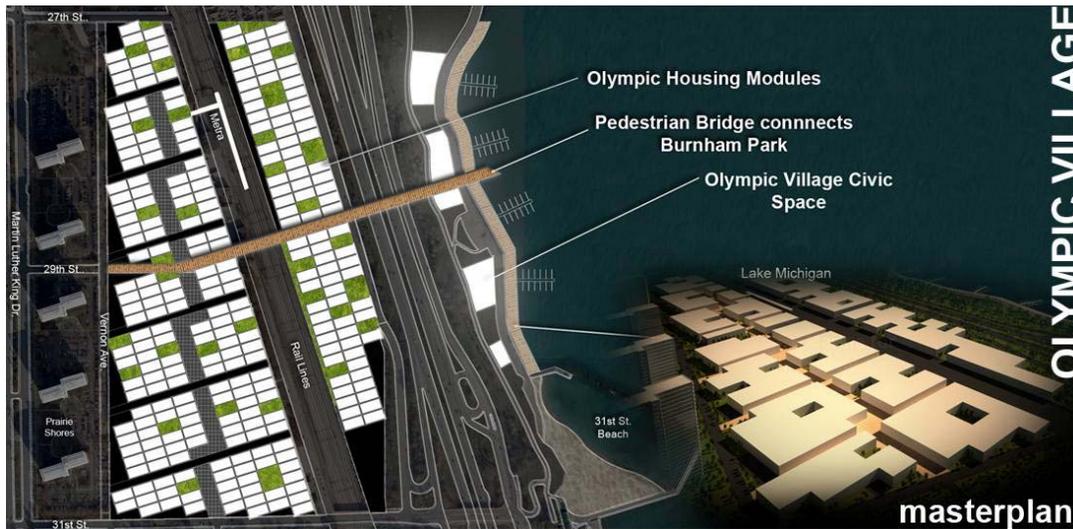
Rendering of full scale model on IIT campus
31st and Federal, Chicago, IL 60616



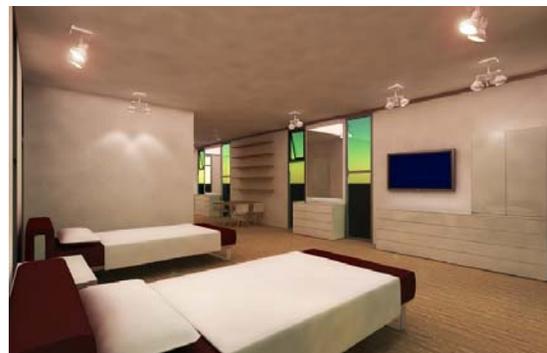
Full-scale model layout



The Olympics team designed the interior and exterior of the site plan for the Olympic village housing idea. Drawing on the site plans from the previous semester, the site was planned out as well as the actual design and layout of the living quarters. However, this group was phased out once Chicago lost the 2016 Olympic bid. The focus of this group was shifted to developing a plan for Illinois Institute of Technology graduate student housing. This new group worked directly with the IIT housing committee to come up with an efficient solution.



Rendering of Olympic Village Design



Interior Rendering of Olympic Village Housing

The Affordable housing team came up with the design and layout of the affordable housing construction. This team researched Chicago housing regulations and costs of materials so that they could develop a sustainable and comfortable housing project plan.



Rendering of Two-Story Single-Family Residence



Kitchen and Dining Room View

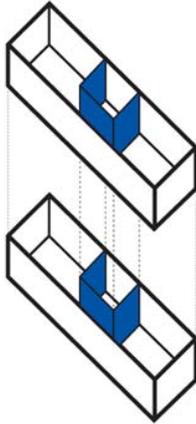


Master Bedroom View

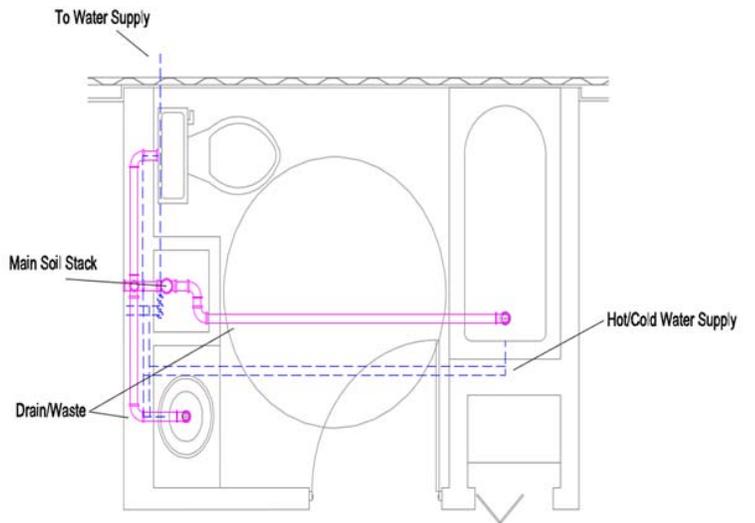


MODULARITY

Ease of assembly

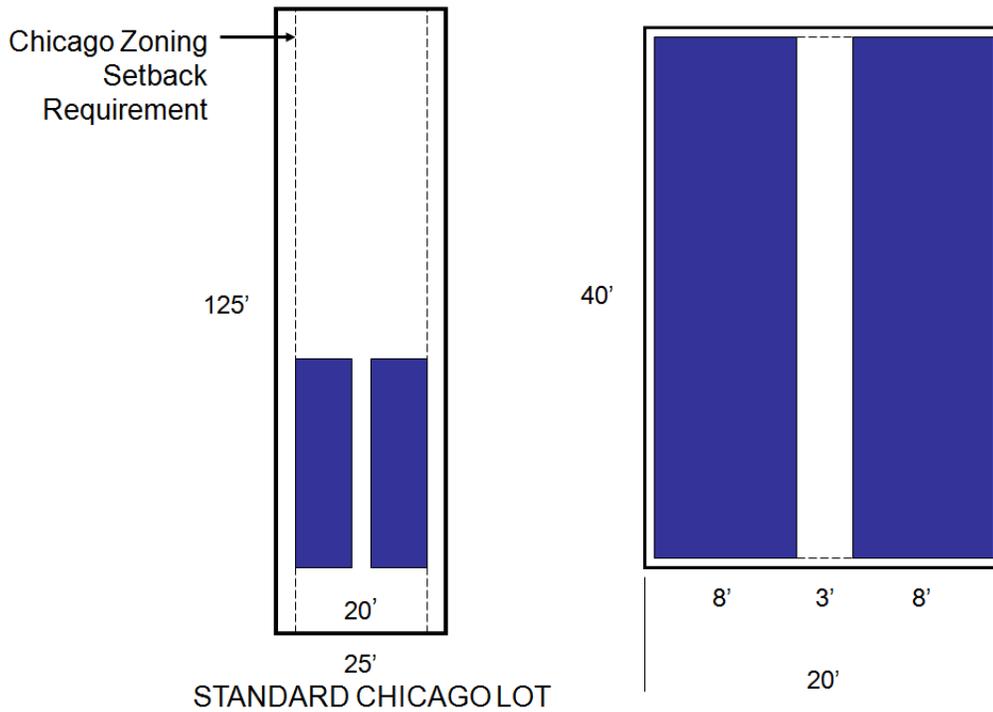


STACKING CONTAINERS /
STACKING PLUMBING



PLUMBING QUICK-CONNECT
DRAWING

AFFORDABLE HOUSING: SHIPPING CONTAINER LAYOUT



The Presentation/Marketing team was in charge of completing the requirements of the class including all of the IPRO deliverables in addition to marketing and promoting this project to its fullest potential. The team created presentation materials to market the project, its goal, and advantages; and served as the public relations contact in coordination with several media outlets.



Sustainabiliity



Olympic Village 2016



43 fans to date!



"Redefining Chicago Housing"

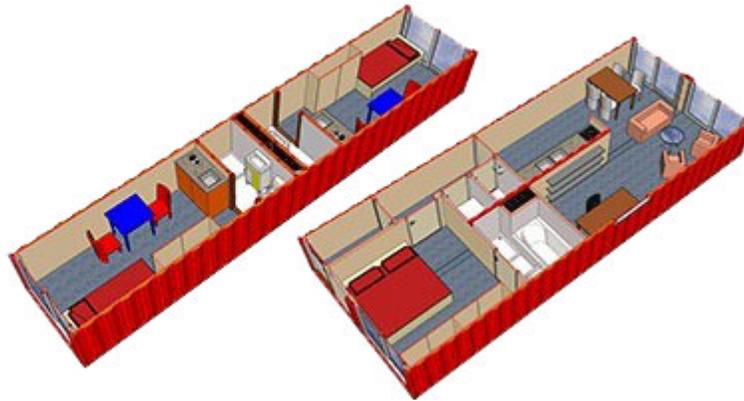
Analysis and Findings

At the beginning of the semester, much focus was devoted to the Olympic Housing aspect of the project. Existing floor plans have been revised and additional renderings created. Moreover, a different layout for the Olympic Village as a whole was developed by the Olympic subgroup.

However, when it was announced that Chicago would not be hosting the Olympics, the team had to regroup into only three sub-teams: Design, Full-scale Model, and Marketing & Presentation. Parts of the work that the Olympic team had done thus far have been incorporated into the Design team's figurative portfolio, but some objectives have had to be abandoned. For instance, the dual-purpose housing concept became irrelevant, as there is not much use for it beyond the original idea of converting the Olympic Village into permanent homes.

Progress has been made on most other objectives set by the group at the beginning of the semester. Continued research of previous uses of shipping containers for housing has yielded some important relevant results, the primary among them being a student housing project in Amsterdam, which has been recently completed.





Research for most cost efficient and sustainable ways of incorporating plumbing, HVAC, and electricity into these units continues, as well as exploring the possibilities to increase energy efficiency.

A draft of the itemized list of materials and components required by the Full-Scale Model team has been completed. In addition, several budgets have been created for the different designs (Olympic housing units, affordable homes, full-scale model). It was found that the team's design would cut down the average cost per square foot in Chicago of \$200 down to \$78 per square foot. These estimates were made using several sources including RS Means, contacting industry professions and so forth.

The Marketing Plan from the beginning of the semester has had to be modified several times; however, the majority of its goals have been successfully met. IPRO 339 can now self-promote through its own website, a facebook page, a brochure, and a letter for potential donors. Furthermore, it has two electronic mailboxes for communications. Awareness of the project within the IIT community has been increased by publishing two articles in each TechNews and IIT Today, as well as through emails circulated through the different channels of the community: individual departments, personal contacts, and student organizations.

Promoting the IPRO group via public radio, TV and the key Chicago publications has not been attempted, due to much delay in the building of a full-scale model. It was decided that major steps of that importance

(that would also involve, for example, contacting the Aldermen) should be put off until the team has made significant progress with the full-scale model or developed a strong, coherent presentation, reflecting the team's identity, mission, and message to the community.

Beyond the original objectives for Marketing and Presentation, the team's identity has been revamped with a new logo and name: it has been changed from "Innovative Housing 2016" to "Innovative Container Design." Additionally, it was decided to substitute the term "entry-level homes" for "affordable housing."

Some research was made regarding alternative types of exterior, but a comprehensive cost-comparison analysis has not yet been accomplished. This has not been actively pursued, in part, because the final designs of the affordable homes for Chicago already feature a brick exterior, since other options for this particular design have been rejected for various reasons.

The alternative materials that have been looked into included fibercement boards, aluminum paneling with honey comb core, metal paneling (or exposing the container), plastic and rubber.

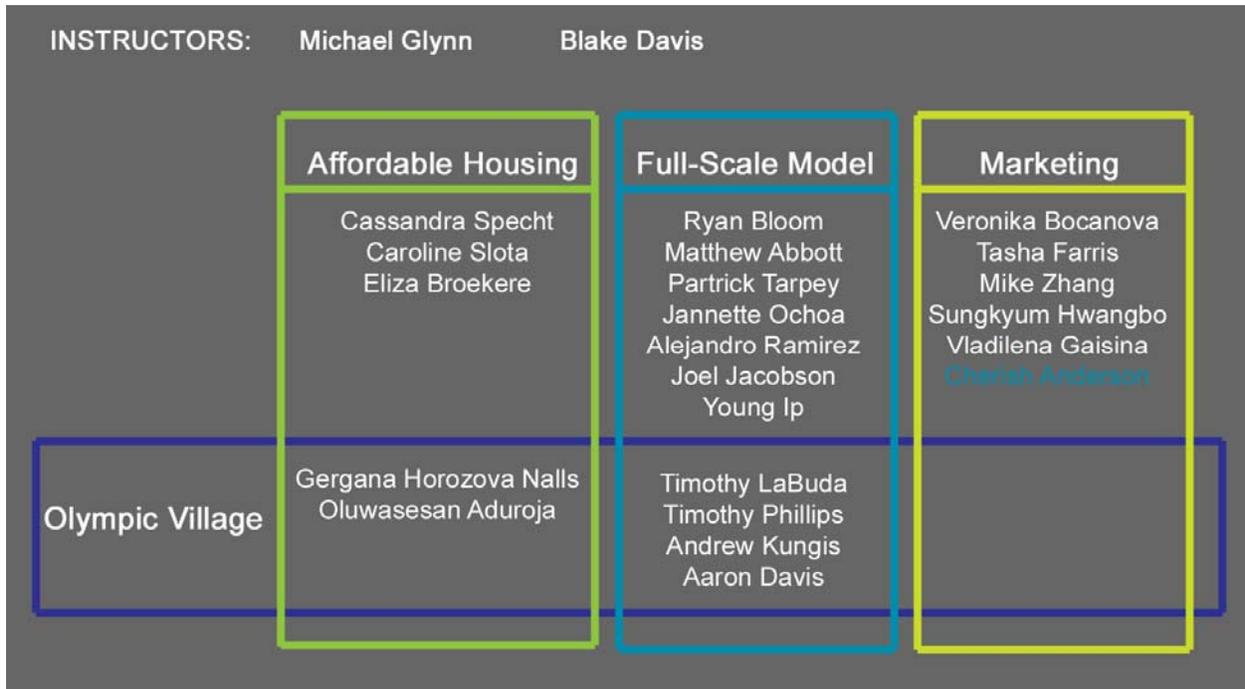
One of the recommendations of the previous semester's team was to obtain feedback from professionals regarding the work and findings of the IPRO group. This has been achieved to some extent through our communication with Stephen Kibler, an Adjunct Assistant Professor at IIT's College of Architecture, whose expertise spans frame structural systems and steel. Professor Kibler has provided valuable comments on the team's main marketing materials - the brochure and the donor letter. He also expressed that he would rather see the team move away from a brick exterior of the housing modules to more interesting and potentially more practical exterior materials. He even suggested the possibility of developing a whole new type of exterior cladding to be used specifically with shipping container housing.

Conclusions and Recommendations

It would be recommended to explore Professor Kibler's suggestion by doing further research into the different types of exterior cladding and evaluating the criteria that an ideal exterior of a container home would have to meet. From there, it can be determined whether or not it would be worthwhile to attempt an innovative exterior design by the group.

The Keetwonoen Student Housing project is perhaps a most prominent example of shipping containers used as student housing. It would be worthwhile monitoring its use and progress, in case IIT is ever to seriously consider building additional dormitories on campus. To this date though, it has been determined not to pursue the creation of additional student housing. This could be an avenue to explore in the future.

Appendix 1. List of Team Members



IPRO 339 Team

Prof. Blake Davis, ARCHITECT
 Prof. Michael Glynn, ARCHITECT
 Matthew Abbott, B. ARCH
 Ryan Bloom, B. ARCH
 Aaron Davis, BS . MECH. ENG.
 Vlada Gasina, BS . MECH ENG
 James Hwangbo, B. ARCH
 Andrew Kungis, B. ARCH
 Timothy Phillips, B. ARCH
 Cassandra Specht, B. ARCH
 Oluwasesan Aduroja, B. ARCH
 Veronika Bocanova, B. ARCH



Young Hong Ip, BS . MECH ENG
 Timothy LaBuda, B. ARCH
 Alejandro Ramirez, BS. ELEC ENG
 Patrick Tarpey, B. INTM
 Cherish Anderson, BS. ELEC ENG
 Eliza Broekere, B. ARCH
 Tasha Farris, B. ARCH
 Gergana Horozova Nalls, B. ARCH
 Joel Jacobson, B. ARCH
 Jannette Ochoa, B. ARCH
 Caroline Slota, B. ARCH
 Mike Zhang, B. CS



<http://www.iit.edu/~ipro339f09/>

ipro339.innovative.housing.2016@gmail.com

ipro339f09@iit.edu

Appendix 2. Team Expense Budget

Item	Price	QTY	Price	Purpose
Models	\$25.00	2	\$50.00	Developing prototypes of our designs for review and further study.
Printing	\$5.00	10	\$50.00	Printing of renderings, floor plans, site plans for in class presentations
Travel Expenses	\$250.00	1	\$250.00	Travel for teams of 3
Labor Supervision and Construction	\$3000-5000	1	\$3000-5000	Necessary for building life size model
Total:			\$5350.00	

Appendix 3. Working List of Contacts

1. **Thomas Jacobius**
 - a. IIT IPRO Director
 - b. jacobius@iit.edu
2. **Steve Kibler**
 - a. Structural Engineer willing to donate his services
 - b. His wife works in the shipping industry and might be able to get shipping containers or other things donated to us.
 - c. kibler.iit@gmail.com
3. **John Collins**
 - a. collinsj@iit.edu
4. **Colette Porter**
 - a. Director of Campus Design & Construction at IIT
 - b. Cporter1@iit.edu
5. **Anna E. Glenn, RPCV, MLA**
 - a. Vice President of Urban Habitat Chicago
 - b. aglenn@urbanhabitchicago.org
6. **Erin Bauer**
 - a. Alumni & Development Officer at the College of Architecture IIT
 - b. ebauer1@iit.edu
7. **Paul Sawyers**
 - a. Intermodal Shipping Container Small Steel Buildings
8. **Matthew L. Simpson**
 - a. Undergraduate student at IIT
 - b. Is a welder and experienced wood worker
 - c. Said he can help build furniture/doors/windows ahead of time
 - d. Has tools (nail guns, compressors, compound mitre, etc.)
 - e. msimpso1@iit.edu
9. **Jose Zamacona**
 - a. IIT BSEE '05
 - b. Volunteer in full-scale construction interest
 - c. zamajos@iit.edu

10. Ji Young Choi

- a. Graduate student at IIT (last semester)
- b. Volunteer in full-scale construction interest
- c. jchoi31@iit.edu

11. Jason A. Neil

- a. Director of Intramurals and Recreation in the IIT Athletic Department
- b. Is very interested in the project (not sure how much time he has to help)
- c. jneal2@iit.edu

12. Asfandyar Khan

- a. Would like to volunteer in full-scale construction
- b. akhan9@iit.edu

13. Sergio Steve Curro

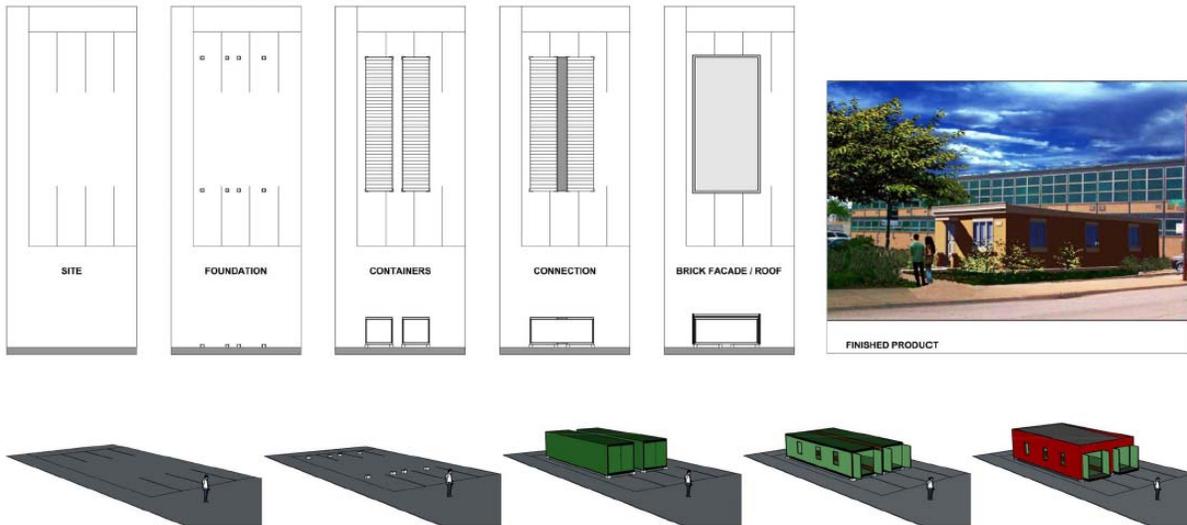
- a. Associate AIA, LEED AP
- b. Construction Engineering and Management at IIT
- c. Is very interested in the project and would like to help
- d. scurro@iit.edu

Appendix 4. Raw Data

The following is an itemized budget that was done to show that our design of Chicago homes using shipping containers truly is more affordable.

2 Bedroom Unit				
CSI NO.	ITEM DESCRIPTION	BASE BID	DIVISION TOTAL	DIVISION PERCENT
1000	General Requirements	\$3.13	\$4,000.00	5.61%
2000	Site	\$23.80	\$30,464.32	42.70%
3000	Concrete	\$0.04	\$56.60	0.08%
4000	Masonry	\$0.92	\$1,183.46	1.66%
5000	Metals	\$0.78	\$1,000.00	1.40%
6000	Woods and Plastics	\$7.02	\$8,987.82	12.60%
7000	Weather Protection	\$1.11	\$1,418.00	1.99%
8000	Doors and Windows	\$3.18	\$4,065.29	5.70%
9000	Finishes	\$2.06	\$2,637.69	3.70%
10000	Specialties and Furniture	\$0.70	\$895.93	1.26%
13000	Special Construction	\$4.30	\$5,500.00	7.71%
14000	Conveying Systems	\$0.00	\$0.00	0.00%
15000	Mechanical	\$5.03	\$6,433.35	9.02%
16000	Electrical	\$3.67	\$4,699.21	6.59%
Subtotal			\$71,341.67	
Gross Square Foot (Per 2 Bedroom Unit)		1,280		
4 Bedroom Unit				
CSI NO.	ITEM DESCRIPTION	BASE BID	DIVISION TOTAL	DIVISION PERCENT
1000	General Requirements	\$3.13	\$4,000.00	5.50%
2000	Sitework	\$23.80	\$30,464.32	41.86%
3000	Concrete	\$0.04	\$56.60	0.08%
4000	Masonry	\$0.92	\$1,183.46	1.63%
5000	Metals	\$0.78	\$1,000.00	1.37%
6000	Woods and Plastics	\$7.02	\$8,987.82	12.35%
7000	Weather Protection	\$1.11	\$1,418.00	1.95%
8000	Doors and Windows	\$3.18	\$4,065.29	5.59%
9000	Finishes	\$2.06	\$2,637.69	3.62%
10000	Specialties and Furniture	\$1.82	\$2,327.91	3.20%
13000	Special Construction	\$4.30	\$5,500.00	7.56%
14000	Conveying Systems	\$0.00	\$0.00	0.00%
15000	Mechanical	\$5.03	\$6,433.35	8.84%
16000	Electrical	\$3.67	\$4,699.21	6.46%
Subtotal			\$72,773.65	
Gross Square Foot (Per 4 Bedroom Unit)		1,280		
Total Olympic Construction Cost				
Total Cost of 2 Bedroom Units			\$71,341.67	
Total Cost of 4 Bedroom Units			\$72,773.65	
Total Project Cost			\$72,773.65	
General Contractor OH&P			\$10,916.05	15%
Contingency			\$7,277.37	10%
Architect			\$7,277.37	10%
Conventional Total Estimated Construction Cost			\$98,244.43	
Total Cost per Sq Ft				\$113.71

IPRO 339 FULL SCALE MODEL PROCESS



Model Project Team – Material List

Construction Materials

- Concrete for foundation pads
- (2) shipping containers
- Plasma cutter rental/donation
- Bricks
- Mortar for bricks
- Exterior grade paint
- Roofing materials (tar paper, flashing, etc.)
- Fastening materials (nails, screws, etc.)
- Wood or Metal Studs
- Drywall
- Interior Paint
- Bathroom Fixtures
- Bathroom Flooring
- Lighting
- Electrical Outlets and Switches
- Electrical Wiring
- Windows
- Doors
- Materials for outside steps (wood, stone, etc.?)
- Any landscaping needs
- Windows
- Interior and Exterior Doors

Hand Tools

- Hammers
- Drills
- Drill Bits
- Screwdrivers
- Saws (Electric and Non-Electric)
- Sandpaper
- Grinders