IPRO 307 FINAL REPORT
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Intermodal Container Transport System Solutions for Chicago Region

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0.1 INTRODUCTION

IPRO 307 is dedicated to finding innovative solutions for the growing intermodal transportation industry. Although the intermodal industry is the backbone of distributing goods to warehouses around the country, for many years it has faced resistance in developing new intermodal yards on concerns of increased emissions, noise, and traffic. This IPRO sought to alleviate these concerns and provide solutions to these issues.

0.2 BACKGROUND

Intermodal transportation is the use of multiple types of transportation such as ships, planes, locomotive and semi-trailers to transport goods in and out of the United States. An example of this would be the importation of goods from overseas that arrive in the United States via cargo ships. Distribution of these goods can vary depending on the distance the container needs to travel. Containers that travel short distances will be done via semi-trailer, whereas containers that have to travel cross country are loaded into locomotives and transported the Midwest for sub-distribution or the other coast for distribution.

IPRO 307 was started a few years ago. The principal objective for the last two semesters was to develop a plan for the city of Gary of an intermodal yard that could be used there. The city of Gary, Indiana was interested in ways to use an existing plot of land which had railroad tracks running through it. These previous IPROs were successful in producing a design, with it being fine-tuned last semester. One element that was to be further developed was the Clark road bridge design.

The IPRO is sponsored by Mi-Jack Products, Inc. based in Hazel Crest, Illinois that produces special cranes utilized in intermodal facilities to move containers to and from train and trucks. This semester, Mi-Jack was interested in seeing green technology being put to use. They were interested in the viability of wind power for intermodal sites, the use of green roofs on intermodal warehouses, as well as the use of both green and brown sites for potential intermodal yards.

There were many ethical and environmental issues that had to be dealt with. The environmental issues the team dealt with include noise, water, air and land quality. The ethical issues involved the effect on the individual and the community. How would a neighborhood feel about having an intermodal facility in their back yard, and what can be done to make the facility as unobtrusive as possible to the neighborhood?

Thus, the new objective for this semester was to develop a prototypical intermodal yard that could be built at a site with traffic that ranged from 7000 to one million lifts per year. It was also to be attractive to the community, by being environmentally positive and providing other advantages.

Finally, the business cost was not looked at, instead focusing on the design of the ideal intermodal yard.

0.3 PURPOSE

This IPRO team's goal was to produce a design which will reduce the impact of intermodal facilities on the existing urban and rural, ecological infrastructure. Intermodal facilities use substantial amount of land which needs to be paved and used for warehouses or railroad tracks. This Intermodal infrastructure creates many negative environmental aspects which range from air quality, noise pollution, drainage, to water contamination. Due to these negative environmental effects, intermodal yards are often looked at as detrimental to their surroundings and property values. This IPRO looked at the negative aspects of Intermodal facilities, making them ecologically sensitive.

The scope of this IPRO was to provide a manifesto of good practices that will improve intermodal transportation to be environmentally conscious and friendly. One of the goals set was to produce a book containing good practices in the design of an intermodal facility. The team was to implement the methods by producing a build-out. The team was also to focus on the Clark Road bridge design from previous semester to help improve the commerciality of Gary, Indiana.

There is a growing concern today to be more environmentally conscious and friendly. Cities like Chicago are introducing green roofs to help the environment by reducing carbon dioxide therefore lessening the green house effects. The challenge for this IPRO team was to improve intermodal yard efficiency while maintaining the highest environmental and ethical standards. The team was to research and find solutions for these issues and write up a report to publish in the book.

To implement the research into actual practice, the team was to provide a build-out containing a generic layout of a 7000 to a million lifts per year per site. The build-out was to reuse a brown site or green site, provide buffers that are environmentally friendly and give back to the community. The team was to also produce a design for a warehouse that is energy efficient and environmentally friendly. The previous IPRO team provided a design for Clark Road in Gary, Indiana to prevent the growing congestion of trucks parked adjacent to Clark Road. Another goal was to improve the design of this bridge. The trucks not only produced congestion but sitting idling on the road also produce fumes that hinders the air quality in the surrounding areas. The bridge would not only provide access to commercial areas but also recreational areas such as the lakefront. The bridge will be accessible via pedestrian and vehicular while being architecturally pleasing.

The following is the breakdown of the hours required for each major task or deliverable.

HOURS ESTIMATED FOR TASKS

TASK NAME	ESTIMATED HOURS
IPRO DELIVERABLES	**340**
Project Plan	25
Midterm Report	20
Code of Ethics	20
Midterm Presentation	10
Meeting Minutes	10
Website	15
IPRO Day Presentation and Rehearsal	100
IPRO Day Poster	10
IPRO Day Map	100
Final Report	30
BOOK DESIGN	**150**
Research and gather information on location	25
Research and gather information on environmental issues	25
Research and gather information on zoning and buffers	20
Research and gather information on excavation	30
Make deliverables	50
BRIDGE / WAREHOUSE DESIGN	**160**
Research bridge/warehouse design	10
Brainstorm on the concept of the bridge/warehouse	60
Determine feasibility of the design with structural engineer	40
Make deliverables	50
BUILD-OUT	**100**
Research on current site and current practices	25
Brainstorm ideas and concepts for an intermodal facility	50
Determine concept to pursue	5
Make deliverables	20

As can be seen, approximately 750 hours were delegated. IPRO-307 had 11 weeks to finalize the project, there were 15 members and each member is expected to commit 6 hours outside of class per week. This yields 11wks *15 members*6 hours = 990 hours total. The 240 hours not accounted for were used for meetings, correspondence, and peer reviews. This allowed for better quality of work to be presented.

0.4 RESEARCH METHODOLOGY

There were three principal tasks to be completed, in addition to the deliverables required by the IPRO office. The tasks set forth in the project plan were a bridge/warehouse design, a build-out of a prototypical intermodal yard, and the design of a good practices book which could be used as a reference source when building an intermodal yard. Each task was completed, with a slight change to the good practices book. Rather than create a book, the team decided it was more useful to concentrate on a power point presentation for the sponsor, Mi-Jack, which could be more easily referenced. This was done in order for the sponsor to be able to quickly and easily understand what was accomplished this semester.

In order to accomplish each task and create the IPRO office deliverables in a timely fashion, a time table of when tasks needed to be completed by was created in the beginning of the semester. In the project plan, which was submitted in the beginning of the semester, the amount of hours necessary for each task and IPRO deliverable was set. In addition to this, the due dates for each task were created based on the amount of time each task would take, in order to keep the team on schedule. Finally, specific due dates were set for the completion of the bridge/warehouse design, the build-out of the typical intermodal yard, and the design of the good practices power point. Specific due dates needed to be set for these tasks, as significantly more work was required to complete these tasks than was required to complete the IPRO office deliverables.

The use of due dates turned out to be an effective way to keep the team on task. Each goal that was set by the team was met by the end of the semester.

0.5 ASSIGNMENTS

Having decided the major tasks to be completed and the hours associated with them, the next step was to determine which team member would be assigned to which project. At the beginning of the semester, each group member was required to submit a CV to our advisor, Professor Laurence Rohter. In this CV, a student was to describe their interests, their strengths, the software they excel at using, and their major. Using these, Professor Rohter was able to delegate the different tasks to those students he thought would be best suited to complete them. Two students were assigned to make sure that the deliverables were completed on time. They were also in charge of assigning IPRO office deliverables to team members.

With these two selection ways in mind, the following students were responsible for their respective tasks.

INDIVIDUAL TASK AND DELIVERABLES COMPLETED:

KEY
- Tasks
* Deliverables

Matthew A.:	* Website with Tony - Buffer Zones and Zoning Issues and GWAN with Arnold
Renee B.:	* Deliverables Monitor with Arnold * Project Plan with Arnold * Meeting Minutes - Build Out with Arnold
Peter B.:	* Midterm Power Point Presentation with Marek * Midterm Report with Marek - Bridge Design with Marek, Lukas - 3D Animation with Marek
Algirdas B.:	* Final Report - Air Pollution/ Quality
Anthony C.:	* Website with Matthew A. - Linear Connections (Bike Paths and Parks)
Daniel F.:	* Midterm Presenter with Jac - Zero-Excavation & Warehouse Design with Matt S.
Arnold I.:	* Deliverables Monitor with Renee * Project Plan with Renee - Buffer Zones and Zoning Issues and GWAN w/ Matthew A. - Build Out with Renee
Lukas J.:	- Current Events - Bridge Design with Marek and Peter
Sebastian J.:	* IKNOW Uploads - Urban Design
Tom L.:	- Rural Design
Ryan M.:	* IPRO Day Power Point Presentation - Water Retention

Joseph R.: * Abstract, Poster
- Noise Control

Matt S.: * Code of Ethics
- Zero- Excavation & Warehouse Design with Daniel

Jac S.: * Midterm Presenter with Daniel
- Industrialized Neighborhood Friendly Green Sites
- Alternative Energy Issues

Marek W.: * Midterm Power Point Presentation with Peter
* Midterm Report with Peter
- Bridge Design with Peter, Lukas
- 3D Animation with Peter

Each of these tasks had either a due date or recommended completion time, which is shown below. Every major task was completed prior to it's respective due date, allowing the deliverable to be presented to the entire class for a peer-review. Although everyone was assigned different tasks, there was always the possibility for anyone to input suggestions on how to improve the overall product.

TASK NAME	START DATE	FINISH DATE
IPRO DELIVERABLES	**2/14/2008**	**5/02/2008**
Project Plan	2/14/2008	2/22/2008
Midterm Presentation	2/26/2008	3/06/2008
Code of Ethics	2/28/2008	3/07/2008
Midterm Report	3/06/2008	3/14/2008
Meeting Minutes	4/03/2008	4/18/2008
Website	4/01/2008	4/29/2008
Abstract, Posters	4/17/2008	4/25/2008
IPRO Day Presentation	4/08/2008	4/25/2008
Final Report	4/15/2008	5/02/2008
IKNOW Uploads	2/14/2008	5/02/2008
IPRO Day Exhibit		5/02/2008
BOOK DESIGN	**1/28/2008**	**4/25/2008**
Research phase	1/28/2008	2/28/2008
Generate materials for book	2/21/2008	3/04/2008
Check over materials	3/04/2008	3/11/2008
Generate generic layout	3/06/2008	3/25/2008
Layout materials for book	3/25/2008	4/01/2008
Produce deliverables	4/01/2008	4/25/2008

BRIDGE / WAREHOUSE DESIGN	**1/28/2008**	**4/25/2008**
Research phase w/ structural engineer	1/31/2008	2/21/2008
Generate alternative design	2/21/2008	2/28/2008
Produce estimate of design	2/21/2008	2/28/2008
Produce deliverables	4/01/2008	4/25/2008
BUILD -OUT	**1/28/2008**	**4/25/2008**
Research site	2/14/2008	2/21/2008
Produce conceptual design for yard	2/21/2008	2/28/2008
Check zoning and possible buffers	2/21/2008	4/03/2008
Finalize design	4/03/2008	4/25/2008
Produce deliverables	4/01/2008	4/25/2008
MILESTONES		
Midterm report and presentation		3/06/2008
Sub-project deliverables completed		4/04/2008
IPRO Day		5/02/2008

0.6 OBSTACLES

There have been a few obstacles to IPRO 307. In terms of IPRO office deliverables, the team members chosen for their respective deliverables were able to produce professional quality work, and the IPRO office has recognized this work by awarding excellent grades for the deliverables thus far.

The obstacles in research which the 307 team faced are drainage, brown sites, existing urban conditions, and the intermodal stigma. The apparent issue when dealing with intermodal is its stigma of pollution. An intermodal yard creates air and water pollution as well as auditory and visual irritants. These issues make intermodal yards virtually impossible to build in urban communities which are trying to avoid this stigma. To deal with this, the IPRO came up with alternative energy production on site, and the use of air emissions data to show that emissions will decrease as the years go by. These environmentally sensitive solutions would relieve the stigma associated with intermodal facilities, thus making them more attractive to urban environments.

Drainage is a major issue at an intermodal facility due to necessity for large amounts of paved surfaces and warehouse structures. Both of these aspects limit the amount of pervious surfaces and contribute greatly to the amount of runoff generated by a facility. Runoff water needs to be directed into a water management system; otherwise flooding will occur, causing property damage to both the intermodal facility and the neighboring properties. To solve this issue the 307 team has investigated local, state and federal flood loads for major storms and calculated square footage requirements to manage the onsite runoff. The team came up with a method of improving site runoff management through pervious paving, onsite retention, and onsite treatment.

A brown site can be defined as derelict property usually with an industrial history and a likelihood of soil contamination. While dealing with runoff on a brown site one must contain all the water on the site (prevent it from running back in to the water table). This proves to be a large obstacle in an intermodal facility because of the large amount of runoff generated due to the paved surfaces, and storage warehouses. While investigating the problem, the 307 team has come up with onsite water treatment options and runoff retention ponds.

For the bridge-design, work proceeded quickly and smoothly because the team members in charge of bridge design were 5th year architect students. They had experience in coming up with aesthetically pleasing design. They worked with a 4th year structural engineering student, who had experience in properly designing bridges. For the other major tasks, which are the build-out and book design, again, the right people were chosen for the job. Thus, one of the keys to success in this IPRO was choosing the best people suited for a job. If this had not been done, it would have been much tougher to complete the specific tasks by their self-set due dates. This also shows the importance of knowing the strengths of team members, so that tasks can be properly delegated.

For future semesters, the most important step is properly delegating the individual tasks.

0.7 RESULTS

Listed below are the major accomplishments of every team. In addition to properly presenting the information in power point form, the results of this semester's work were posted on the website, which is http://omega.cs.iit.edu/~intermodal. This website was designed with simplicity in mind, so that future IPRO 307 teams could easily add their work. This also gives the sponsor, Mi-Jack, quick and easy access to the end result of this semester.

THE IPRO DELIVERABLES TEAM

The team was on task for every IPRO deliverable throughout the semester. The team composed deliverable task lists, and continuously updated the 307 team on important dates and events regarding IPRO office requirements.

THE BUILD-OUT TEAM

The build out team began their work this semester by researching a few intermodal yards in the vicinity of Chicago. The research included yards such as Bedford Park, Joliet, Crete, and La Porte in order to develop an understanding of the interaction between the intermodal yard and its context. The team then went on to develop a schematic design of Bedford Park assessing the square footages of different functions within the yard. The team then used the information to develop a strategy for water drainage based on paved and unpaved percentages of the yard. In addition to the drainage issue the team has also began to develop

buffer zone solutions for yards located in residential and urban settings. The team designed a layout for an intermodal yard which will address the above stated issues in an urban and a rural setting. The main deliverable of this team was a poster for IPRO day, and a slide in the final power point presentation to be given to the sponsor.

THE BOOK DESIGN TEAM

The book design team developed a power point presentation demonstrating the different options and solutions to water drainage and purification. The slides include wet and dry pond design schematics as well as engineered wetlands layout. The team has also researched permeable paving by Ozinga and possible onsite energy production strategies. Significant research was done on air pollution. It was shown that emissions from intermodal yards will decrease over the next decade despite increasing container traffic. This was depicted in the power point presentation and on a poster for IPRO day. The team is investigated wind, solar, and natural gas means of harvesting energy in order to reduce pollution, while making the yard less reliant on the power gird for its electricity. Wind power was chosen to be the best alternative source of energy, due to the cost and favorable conditions for wind turbines. The output was depicted on a poster for IPRO day, and was published on the website. To better understand the issue of noise pollution, the team has sought outside reference from IIT staff. A graphic was displayed on one of the IPRO day posters which show the areas affected by noise from a neighboring intermodal yard. In addition, strategies to reduce this noise were discussed. The primary deliverable of this team was a poster for IPRO day. All of these products were posted on the website of the IPRO.

BRIDGE/WAREHOUSE DESIGN TEAM

The team investigated and ruled out green roofs as the primary warehouse roof solution due to structural cost and therefore feasibility of the design. However, green roofs can be implemented where structurally feasible. The team finished work on a zero-excavation warehouse design for brown or contaminated sites. This allows for the use of this virtually unusable land which is well qualified for intermodal yards and their related uses. The bridge is complete with the incorporation of water purification and retention. A three dimensional model of the bridge has been made. An animation for the final IPRO presentation was created from this model, in order to better show the design. For the zero-excavation warehouse, a poster was made, describing in detail the zero excavation warehouse design as well as other environmental solutions.

CONCLUSIONS

The IPRO team produced 4 posters, a power point, and a website for the sponsor, Mi-Jack. Some of the products, such as the zero-excavation

warehouse, are limited in their usability, as the plans need to be reviewed and signed off on by certified professionals before they can be used. Others can be used right away, such as the air emissions decline and noise pollution graphs. All of them can be considered by the sponsor, who can then decide whether or not to pursue the ideas presented in them or not.

In terms of the team, although many people were well-suited to doing one task, they were also assigned to something they were new to. Thus, they were able to learn about alternative energy, estimating pollution, etc. The IPRO presented many opportunities to learn about different areas that are not covered in coursework.

The implications of the findings of this IPRO are great. For instance, the ability to implement the zero-excavation warehouse will be a large step forward for the intermodal industry. Besides saving money by not moving soil off-site, the warehouse will be on a brown site, which is contaminated soil. Rather than being an unusable plot of land, brown sites will be put to use without negative impact to the environment. Another instance is the air pollution data. Railroad companies will be able to pitch intermodal yards much more effectively, as they will be able to show residents that pollution will decrease rather than increase. Finally, the bridge-design can be implemented to provide a environmentally friendly as well as visually pleasing element to a piece of land for Gary, IN. Thus, the societal benefits will be large if these suggestions are implemented.

Finally, it gives the next IPRO team something to build on. The next team will be able to further refine these findings, and make them more feasible for the sponsor.

0.8 RECOMMENDATIONS

There are a few recommendations for next semester's IPRO 307 team. One is to continue research on alternative energies, specifically solar power. Because an intermodal yard takes up a lot of space, there is potential to have some sort of energy source on site. Solar power seems to be ideal for it, as the warehouse of a typical intermodal yard is around one million square feet. The problem is that a warehouse if not built to withstand the weight of solar panels across the area of the roof. Thus it is necessary to investigate how many solar panels can be added before the warehouse's design has to be strengthened, and what is the cost benefit associated with it.

Another recommendation is to research dynamic braking, something which the team did not have time to do. When a freight train, which is traveling cross-country, applies its brakes, the engine acts as a giant compressor and creates a lot of electricity. This electricity is dumped as heat, by sending it through resistors in the locomotive. As there is a decent amount of charge being produced, it makes sense to investigate how much is being produced on a typical journey, and what is the best way to harness this power.

Finally, the next team should also look at full brown site redevelopment. They must develop strategies for one hundred percent water retention, in order to make the brown site fully usable. This would be the best impact environmentally.

0.9 REFERENCES

The following sources were used in producing the work for this semester:

For the bridge design team, the final animation was done with the help of Antonio Callado, Technical Director @ AnimaGraph Arte Digital Ltda. He may be contacted at antonio.callado@animagraph.com.

For the warehouse design, the software Architectural Graphics Standards CDROM Version 3.0 was used.

For the bike path and skate park design, the following websites were used:

http://www.dot.il.gov/bikemap/devfunds.html
http://www.sccrtc.org/bikes/AASHTO_1999_BikeBook.pdf
http://www.dot.il.gov/desenv/BDE%20Manual/BDE/pdf/chap17.pdf
http://www.dot.il.gov/bikemap/bikehome.html
http://www.skateparkguide.com

For the environmental research, the following websites were used:

http://www.bts.gov
http://www.epa.gov/owow/
http://www.sws.uiuc.edu/
http://www.fhwa.dot.gov/

In addition to this, the following report was used as a reference:

Li, Wei, Jing Yuan, Chan Pham, and Hector Castaneda. Health Risk Assessment for the BNSF Hobart Railyard. California Environmental Protection Agency Air Resources Board. 2007.

0.10 ACKNOWLEDGEMENTS

The following students contributed to the work of this IPRO. Their individual contributions are listed in section 0.5, Assignments.

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Peter Beran
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Our advisor was Professor Laurence Rohter, PE IIT. He was the guide of the IPRO, made sure that the team stayed on task, and provided valuable input in the final products of the IPRO. He was also the primary contact with the sponsor, MI-Jack. He provided us with information on what they were interested in seeing, and helped us deliver the results to them.

Our professional advisor was Peter Mirabella of Mi-Jack cranes. He was interested in seeing green initiatives, and occasionally came in to receive status reports from the class.