IPRO 307: Intermodal Container Facility Improvements

Sponsored by: MI-JACK Products

Presented by: Michael Krueger, Ryan Maas, Andrey Kolesnikov
Problem Statement

• Identify and meet our client’s needs while proving the logistical, engineering and financial feasibility of the proposed technology.
WHY?

• The current industry “norm” is to use trackside storage with gantry cranes or fork lifts when the truck arrives.
• The proposed technology uses a buffer system to lower the intermodal unit onto the truck chassis when it arrives.
• Eliminates the need for an individual operator to go back and forth throughout the yard when a truck arrives.
Goals

• To enhance the productivity of Harvey Intermodal Storage Yard and Trucking Terminal by providing a new crane structure that utilizes buffers.
• Increase the number of average lifts per year from 300,000 to 1,000,000.
• Prove that such a crane is possible, capable of holding that capacity of production, and potentially profitable.
• Cost estimate for the implementation and creation of this system.
Team Structure

- Each meeting is run by a different Session Leader who was secretary at the prior meeting.
- At the beginning of each meeting, a secretary is appointed for the next meeting.
- The group will be divided into sub-groups with six major areas of focus.
# Breakdown

<table>
<thead>
<tr>
<th>Name</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallagher, Ellen</td>
<td>Foundations Subgroup Leader</td>
</tr>
<tr>
<td>Gregory, Nicole</td>
<td>Foundations Subgroup Member</td>
</tr>
<tr>
<td>Hartwig, Michael</td>
<td>Layout Subgroup Leader</td>
</tr>
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<td>Krueger, Michael</td>
<td>Layout Subgroup Member</td>
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<td>Kutryn, Anna</td>
<td>Layout Subgroup Member</td>
</tr>
<tr>
<td>Kolesnikov, Andrey</td>
<td>Mechanical Subgroup Leader</td>
</tr>
<tr>
<td>Loquidis, Ryan</td>
<td>Mechanical Subgroup Member</td>
</tr>
<tr>
<td>Pirkle, Matthew</td>
<td>Mechanical Subgroup Member</td>
</tr>
<tr>
<td>Haucke, Stephen</td>
<td>Pavement Subgroup Leader</td>
</tr>
<tr>
<td>Hafdi, Kamal</td>
<td>Pavement Subgroup Member</td>
</tr>
<tr>
<td>Sun, Yuefeng</td>
<td>Simulation Subgroup Leader/Mechanical Member</td>
</tr>
<tr>
<td>Gima, Daniel</td>
<td>Simulation Subgroup Member</td>
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<tr>
<td>McCloat, Declain</td>
<td>Simulation Subgroup Member</td>
</tr>
<tr>
<td>Maas, Ryan</td>
<td>Structural Subgroup Leader</td>
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<tr>
<td>Guglielmo, Kyle</td>
<td>Structural Subgroup Member</td>
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<tr>
<td>Olney, Peter</td>
<td>Structural Subgroup Member</td>
</tr>
</tbody>
</table>
IPRO 307

Problem Statement

Goals

Team Structure

Obstacles

Final Progress

Next Steps

Questions?

**Team Structure**

**Site Layout**
Provide data on existing area and design efficient layout

**Pavements**
Designing paving systems for truck traffic area

**Foundations**
Design the foundations for structure and superstructure of the system

**Mechanical**
Calculations for internal and external forces on the system from MiJack cranes

**Simulations**
Interactive design to phase out old system while also implementing new system.

**Structural**
Design the main structure of the system to support the superstructure of the system.
Obstacles

- Defining the scope of the project
- Determining whether the 1,000,000 lifts could actually be possible with the space and time restrictions of the crane
- The size and number of the cranes
- Stability of the structure
- Placement of the entire system in the existing yard
Final Progress

- Simulations
  - Defined terms
  - Initial “proof of concept” run to show that there would be enough space to accommodate the increase in production
  - Proved that 4 tracks would be necessary and buffers should be two high
  - Created a loading pattern

1 Civil, 1 Mechanical
Problem Statement

Goals

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Obstacles

Final Progress

Next Steps

Questions?
Day 1: 6 trains arrive 6 trains depart = (+960 - 960)
Day 2: 6 trains arrive 6 trains depart plus decay of previous day’s delivery (+480 + 960 - 960)
Day 3: 6 trains arrive 6 trains depart plus decay of previous day’s delivery (+192 + 480 - 960 - 960)
Day 4: ...

Full example:

D1: (+ 960 - 960) = 0
D2: (+480 + 960 - 960) = 480
D3: (+192 + 480 + 960 - 960) = 672
D4: (+96 x 192 + 480 + 960 - 960) = 768
D5: (+0 - 96 + 192 + 480 - 960 - 960) = 768
D6: (+0 - 96 + 192 - 480 + 960 - 960) = 768
D7: (+0 - 0 + 96 - 192 + 480 - 960 - 960) = 768
D8: (+0 - 0 + 0 - 96 + 192 - 480 + 960 - 960) = 768

In this case we can see that with 6 trains in and out per day, we will occupy 768 of the available spaces.

Therefore, using the pattern discovered above, we must determine how many trains in and out will overload our yard.

<table>
<thead>
<tr>
<th>Trains IN AND OUT / day</th>
<th>IM's in / out</th>
<th>Decay / day</th>
<th>Total Occupied space at all times</th>
<th>Lifts /</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1280</td>
<td>0.5</td>
<td>640</td>
<td>Day 2560</td>
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<tr>
<td></td>
<td></td>
<td>0.3</td>
<td>384</td>
<td>Year 798720</td>
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<tr>
<td></td>
<td></td>
<td>0.1</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1</td>
<td>128</td>
<td></td>
</tr>
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</table>

- Too many

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<tr>
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<th>IM's in / out</th>
<th>Decay / day</th>
<th>Total Occupied space at all times</th>
<th>Lifts /</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1120</td>
<td>0.5</td>
<td>560</td>
<td>Day 2240</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3</td>
<td>336</td>
<td>Year 688880</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1</td>
<td>112</td>
<td></td>
</tr>
</tbody>
</table>

- This is the maximum number of trains our system can handle without overflowing the available spaces. This is under 1 Million lifts!

Therefore, we know that availability of spaces DOES control!!
Final Progress

- Mechanical
  - Full renderings
  - Dynamic loads
  - Crane interference clearance

Questions?

1 Engineering Management, 1 Aerospace, 1 Mechanical
Final Progress

- **Structural**
  - Superstructure and Substructure designed to accommodate loads of the crane and containers
  - Frame designed to carry the crane up and down the span of the tracks
Final Progress

• Site Layout
  – Full overlay of aerial photography
  – Analyzed gradations and water retentions
  – Created two options for the cranes positioning.
  – Proposed best option based on the owners needs and cost effectiveness
  – Creating preliminary staging plans and finalized design
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Map of North America with various cities and ports marked. The map includes symbols for different types of hubs and partnerships.
Option A

Pros:
- Minimal Building Relocation
- Do not have to shut down/relocate maintenance area
- Could potentially reroute intermodal terminal to middle of yard for better space utilization

Cons:
- Retention pond
- Have to shut down half of intermodal lines during construction

Deciding Factors:
- Cost of moving retention
- Cost of building demolition/relocation
- Cost of land clearing
- Yard operation during construction
- Yard operation after construction
- Traffic flow of trucks, trains, other vehicles

Staging:
- Relocation of buildings
- Relocation and fill of retention ponds
- Land clearing and grading
- Lay foundations
- Lay rails
- Build crane structure
- Place cranes 1, 2, 3
Option B

Pro's:
- Do not have to shut down any existing intermodal lines during construction
- Retain existing intermodal infrastructure for overload capacity
- Do not disrupt much of the retention/detention areas

Con's:
- Must relocate several buildings/maintenance facilities
- Must relocate all rails in area
- Several areas must be cleared and graded

Deciding Factors:
- Cost of moving retention
- Cost of building demolition/relocation
- Cost of land clearing
- Yard operation during construction
- Yard operation after construction
- Traffic flow of trucks, trains, other vehicles

Staging:
- Relocation of buildings
- Relocation and fill of retention ponds
- Land clearing and grading
- Lay foundations
- Lay rails
- Build crane structure
- Place cranes 1, 2, 3
• Final layout still allows for the existing yard to remain operational throughout most of construction and can be used for overflow if crane requires emergency maintenance.
Final Progress

- Pavements
  - Typical Pavement cross sections calculated for the entire system
  - Runoff and retention data collected

Questions?

Team Structure

Goals

Obstacles

Final Progress

Next Steps

Questions?

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2 Civils
Final Progress

• Foundations
  – Forces calculated
  – Geographical data collected
  – Footings and Load bearing plates were designed.
Problem Statement

Goals

Team Structure

Obstacles

Final Progress

Next Steps

Questions?
TOTAL: $74,424,326
Next Steps

- Verifying cost analysis
- Verifying crane design capacity and detailing
- Integration of the system to the yard
- Cost Benefit Analysis
Questions?
Thank you!