Box Truck and Route Optimization

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Introduction

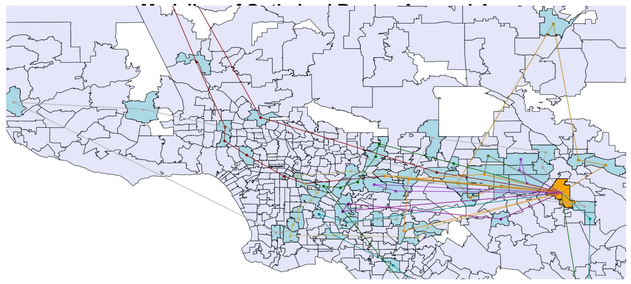
Amazon is an international technology company based in Seattle that focuses on e-commerce, cloud computing, digital streaming, and artificial intelligence.

Problem Definition: Amazon is using third party box trucks to deliver small parcel and large shipments with little visibility and moderate utilization of truck capacity resulting to low cost efficiency.

Goal Statement: Optimize transportation methods and box truck capacity from vendors to Inbound Cross Dock (IXD) facilities in order to reduce costs and save time.

Routing Model

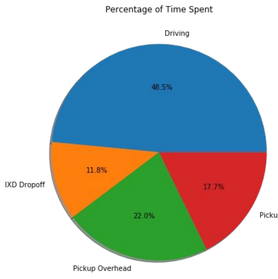
A key part of the capstone project was to create a realistic model for Amazon's entire distribution system, using routing data supplied by Amazon. This involved the writing of over 2000 lines of code to optimize and accurately simulate Amazon's distribution system.



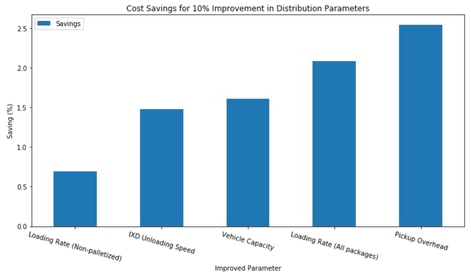
We broke down where resources are being spent. Below is a figure showing a pie chart to highlight this.

Analyzing the effect of parameters on distribution cost allowed us to gain insights on what improvements were most effective.

Cost Breakdown

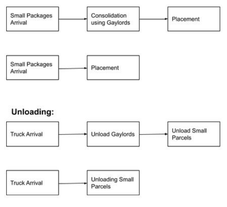


Sensitivity Analysis



Why Gaylords?

- Gaylords improve process flow with regards to time and utilization
- Consolidation into gaylords helps decrease damage by about 53%
- Optimal standard operating procedure (SOP) is to stack packages by wall-building according to our Excel trial studies



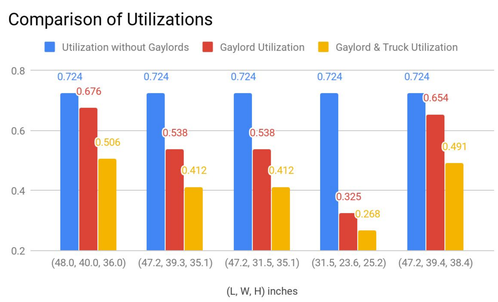
Gaylord Study

As said in the previous section, to best utilize a box truck's capacity, small parcels must be consolidated. This can be done by using gaylords. There are three main types:

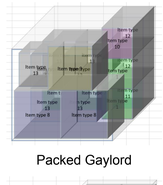
Type	Cardboard	Wire	Plastic
Visual			
Price	$21.25	$40	$115
Lifespan	Weeks	* not suitable for shipping *	Years

Testing with a Sample Route

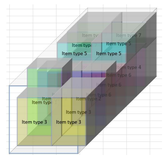
In order to further test and compare gaylord sizes, we needed to visualize how they fit into the truck to find the best truck capacity utilization. Using a Container Loading Problem open-source spreadsheet [1], we tested how 21 shipments fit into gaylords and the box truck. As shown in the graph below to the left, the larger the gaylord, the better the overall truck capacity utilization. Below to the right are pictures of the optimally packed gaylord and box truck, both using cardboard gaylords of 48" x 40" x 36" size.



[1] https://people.bath.ac.uk/ge277/clp-spreadsheet-solver/



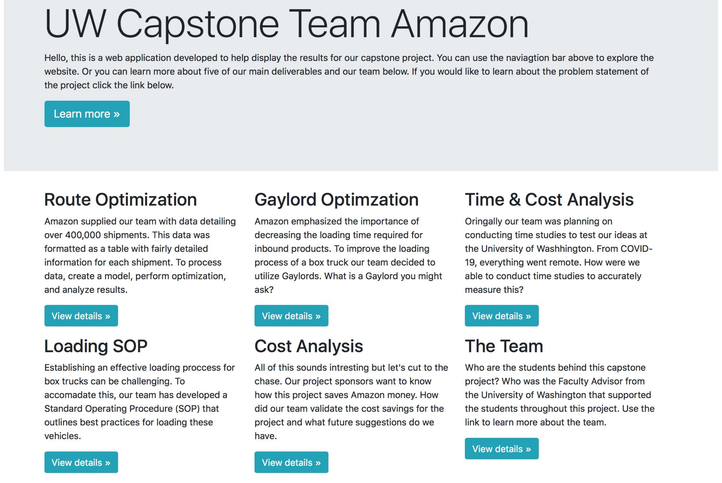
Packed Gaylord



Box Truck Packed with Gaylords and Pallets

Web Tool

As the world transitions to a remote setting, our team thought that it would be important to have a platform to display our results to our project sponsors.

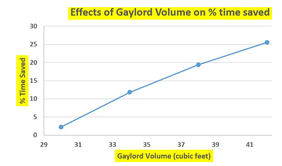


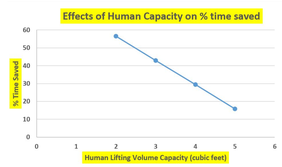
Link to the website: http://tyandrewgood.pythonanywhere.com/

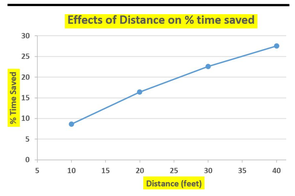
Cost & Feasibility

Amazon has three shipping methods: using their own box truck, hiring a box truck company, and using third parties such as UPS & USPS. According to our research, the cost of daily usage for buying or hiring a box truck is $201.09 or $350, respectively. It is cheaper for Amazon to purchase their own box truck than hiring a box truck and driver. Additionally, we found the break-even point for the use of Amazon owned box trucks compared to using USPS or UPS. Amazon would only need to ship 15 medium sized packages to validate the use of buying a box truck versus using UPS or USPS. Since a box truck has the capacity to store 104.4 medium sized packages, it is certainly capable of exceeding that margin.

Time Study







Process Step	Work Element	Calculations	Metric
Without Gaylord	1. Lift & walk boxes to truck	313.7	seconds
	2. Lift boxes into truck	158.1	seconds
	3. Sort boxes in truck	191.8	seconds
	4. Unload boxes from truck	301.2	seconds
	Total time =	16.1	minutes
	Percent Time Saved =	22.59	%
With Gaylord	1. Build Gaylord on pallet	105.4	seconds
	2. Load Gaylord by hand	156.9	seconds
	3. Lift & walk Gaylord to truck	105.4	seconds
	4. Load Gaylord in truck using liftgate	42.1	seconds
	5. Roll pallet jack	21.1	seconds
	6. Lift Gaylord	126.4	seconds
	7. Place Gaylord	42.1	seconds
	8. Unload Gaylord from truck	147.5	seconds
	Total time =	12.4	minutes

Using a 40 cubic ft. gaylord, we found the loading & unloading process is 22.59% faster.

Variables that impact loading/unloading time

Gaylord Volume: Gaylords can be made in different sizes, although we found the optimal gaylord capacity to be 40 cubic feet.

Human Capacity: How much a person can carry in cubic feet varies, we assumed 4.5 cubic ft.

Distance: The distance from vendor goods to where the box truck can park varies with different vendors. We assumed 30 ft. in our calculations.

Results

- It is cheaper for Amazon to **purchase** their own box truck
- Truck capacity goes from **72.4%** without gaylords to **50.6%** with gaylords
- The loading/unloading process is **22.59%** faster when using a gaylord
- Stacking gaylords will **double** truck capacity
- Gaylord usage was found to offer a **1.75%** net savings
- Shipments sent both third party and internally saves **2.1%** of costs

Future Recommendations

- Implement gaylords in box trucks slowly and record data to validate the use of the tool
- Create simulations based on the data generated from the optimization model and compare it with implementation data to see how accurate it is
- Combine the optimal gaylord model with the route model to create routes based on pickup sequence

Acknowledgments

This project was possible with the support of our Amazon sponsors, Lei Chen and Savannah Beroud, and our professor, Patty Buchanan. Thank you!