Team 6

Amazon Spillage & Containment

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Customer Background

We are collaborating with Amazon's RME team (reliability, maintenance, and engineering teams) to develop a more effective approach to mitigate the occurrence of amnesty during package transit. Amnesty, which refers to the opening and spilling of packages, results in damage and downtime on the conveyor belts, thereby reducing overall efficiency. As a rapidly growing and expansive organization, Amazon offers a vast array of items, which can spill for various reasons. One of the reasons is improper preparation, which involves placing each item in a plastic bag, bubble wrap, or sealing it with tape to prevent spillage. If the item does open, the packaging should contain it. The preparation of items follows specific standards, which require dropping the item at a height of 3 feet, three separate times onto a concrete platform. If the item can withstand this test, no further preparation is necessary. However, if the item fails the test, it requires specific preparation, depending on the item type. This responsibility falls on both Amazon and the people shipping to Amazon for fulfillment by Amazon. Furthermore, during our time on the floor, we discovered that not all associates are aware of the items that should not be packaged. We also identified some key areas of high impact force that cause breakage, as the force experienced at those points is higher than the force experienced during the testing protocol for preparation. Overall, we had to put in a lot of work to understand the problem and our client to produce the best solutions and outcomes.

Problem Statement/Scope of Work

The Amazon Fulfillment Centers are in need of a solution to reduce liquid amnesty, unknown risks product, quality culture, lack of standards, operations maintenance, and engineering dichotomy. Evaluate the current system and find the root cause of spillage and where we can implement solutions to prevent or eliminate spillage from happening and/or contain it when it occurs in a cost-effective manner and minimizes the human element during the high-pressure time constraints windows such as the 2-hour slam window.

Requirements Matrix

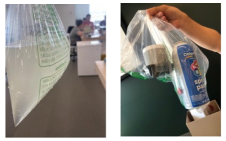
PROJECT NAME:	Amazon Conveyor Spillage Containment
PROJECT NUMBER:	6
CREATION DATE:	9/13/2022
REVISION:	1st revision
REVISION DATE:	10/22/2022
PREPARED BY:	Halim Tienda
TEAM MEMBERS:	Halim Tienda, Kendal Miller, Harrison Ho, and Ethan Hirsh
CAPSTONE TEAM:	Amazon Conveyance System
CORP SPONSOR:	Amazon
CORP REPS:	Jean-Jacques Patry and Joe Good
ACADEMIC MENTOR:	James Condron

Req. #	DESIGN REQUIREMENTS	DESIGN TARGETS / RATIONAL	VALIDATION	COMMENTS
1	Solution must be scaleable	To be detrimined (need to ask Client this week about which fulfillement centers would they test our solution in. As well as ask about design target for this metric this week)	Test runs in Different Fulfillment Centers	After narrowing down our scope this past week scalibity means only in fulfillment centers like MDW7
	During our Intial Meeting with JJ and Joe he told us that he wanted a solution that was scaleable and cost effective.			
2	Cost Effective	To be detrimine (I want to look at the cost of Prep for current one gallon volume then take the average of the cost. Ask amazon if our solution is at most the average if that is an acceptable design target or if they want it to be a lower max than the average	Test runs in Different Fulfillment Centers	Review current prep for a multitude of products with a volume of one gallon and find out what the hourly rate used to calculate prep time cost is. Will enabale us to ask Amazon about Design Targets for this Design requirement.
	During our Intial Meeting with JJ and Joe he told us that he wanted a solution that was scaleable and cost effective.			
3	Minimal Impact on Tact Times	Track Average Tacts times during normal process and during the test run of our solution and compare	Record Tact Times during the test runs of our solution and normal process	
	During our initial meeting with Amazon, JJ and Joe told us that they have a bagging process already implemented at cites. However this process isn't followed by associates because of it impact on their tact times			
4	Design for the containment of liquid items with a volume of one gallon	At least contain a volume of one gallon	Test solution on a multitude of different one gallon volume items	
	On October 20th, during our weekly meeting with Amazon we narrowed down our scope to liquid with volumes of one gallon or less.			

Experimentation and Concepts

Air Column Bags Bubble Wrap Bags

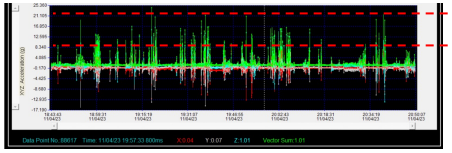
Poly Bags



Area #	Test Area - MJQ5 Fulfillment Center	Avg. Max Vector Force (G)
1	From truck unloading to before first turn to before go up	9.87
2	First waterfall and horseshoe	8.39
3	First upper horseshoe till before singulator	12.46
4	From singular rollers till after shark fin	14.65
5	After shark fin through singlator before scanner	10.48
6	Belt after singluator, through scanner and on main sorter, diverted to problem solve, stopped before gravity spiral	11.96
7	Top of gravity spiral down to problem solve area (GR2-2)	11.58
8	On main sorter, no diversions, horseshoe to recuurculator	12.65
9	Gravity fall from recurlator back to belt before sharkfin	8.11
10	Down gravity shoot convayor	7.46
11	Regualr 3 ft drop	7.06

Biggest Impact Force Areas

1. The shark-fin (4) ~ 15G
2. Horseshoe after main sorter for recirculatory belt (8) ~ 13 G
3. Upper Horseshoe before shark-fin (3) ~12.5G
4. With human interaction as high as 23G



MQJ5 Testing Data Trial 2, Verification

Clearly the current 3-foot drop does not even meet the max forces experienced

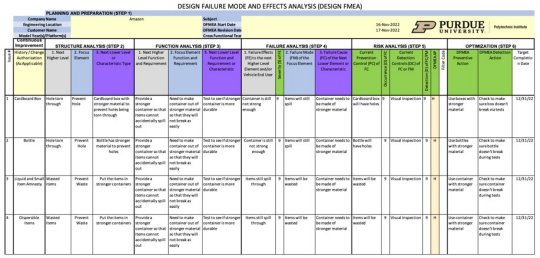
Final Design

Requirement Factors for Solutions To Contain Spill of a < 1 gallon glass liquid

Columnt	Weight [g]	Item	Cost	Size [LxWxH] [cm]	Supply Chain Ability (1-10)	Average Time to Source/Test Time [sec]	Compatibility with Other Items (sizing/fit)	Max force withstood [N]	Ease to Implement	Cost to implement (not including per item cost) (USD)	How well does it contain? (1 = not at all, 10 = fix perfect)	Does it protect item from breaking	Testing: Drop Test #1, 6 Feet 0 inch — Force Experienced [N]	Did it contain the spill? (Y/N)	Drop Test #2, 6 Feet 0 inch — Force Experienced [N]	Did it contain the spill? (Y/N)	Drop Test #3, 6 feet 0 inch — Force Experienced [N]	Did it contain the spill? (Y/N)	Avg. Drop Test Result from 6 feet 0 inch — Force Experienced [N]	Did it contain the spill? (Y/N)
Do Nothing/Current (Cup seal with bubble wrap)	513.4g	Tomato Sauce	Low	(7.5-2x7x11)[cm]	TBD by Amazon	10.04	10	22.26g	10	TBD by Amazon	10	yes	15.22g	Y	22.26g	Y	13.6g	Y	17.033	Y
bubble wrap	541.37g	Tomato Sauce	Medium	(13.5x10x14)[cm]	TBD by Amazon	12.055	7	11.64 g	10	TBD by Amazon	10	yes	5.6 g	Y	11.64 g	Y	11.33 g	Y	9.52 g	Y
Air Bag Sleeve	560.16g	Tomato Sauce	High	(13.5x13x9)[cm]	TBD by Amazon	21.2025	4	19.88 g	5	TBD by Amazon	10	yes	16.39 g	Y	19.7 g	Y	19.88 g	Y	17.68 g	Y
Do Nothing/Current (Cup seal with bubble wrap)	678.98g	Glass Mason Jar	Low	(6.7x7.4x13)[cm]	TBD by Amazon	12.8175	10	N/A	10	TBD by Amazon	5	No	N/A	N	N/A	N	N/A	N	N/A	N
bubble wrap	686.56g	Glass Mason Jar	Medium	(9.5x9x16.3)[cm]	TBD by Amazon	15.0825	7	N/A	10	TBD by Amazon	1	No	N/A	N	N/A	N	N/A	N	N/A	N
Air Bag Sleeve	707.70 g	Glass Mason Jar	High	(16.5x9x9.5)[cm]	TBD by Amazon	17.6875	4	N/A	5	TBD by Amazon	5	No	N/A	Y	N/A	Y	N/A	N	N/A	N
Air Bag Sleeve	707.78g	Glass Mason Jar	High	(19x15x13.5)[cm]	TBD by Amazon	17.6875	4	21.01 g	5	TBD by Amazon	10	Yes	18.92g	Y	19.96g	Y	21.01 g	Y	19.97g	Y
Do Nothing/Current (Cup seal with bubble wrap)	614.43g	Red Bull Cans	Low	(19.5x6.1x5.5)[cm]	TBD by Amazon	9.2825	10	18.8 g	10	TBD by Amazon	10	yes	16.78 g	Y	18.8 g	Y	10.89 g	Y	16.16 g	Y
bubble wrap	614.48g	Red Bull Cans	Medium	(21.3x8x8.1)[cm]	TBD by Amazon	11.2075	7	20.17 g	10	TBD by Amazon	8	yes	17.92 g	Y	11.24 g	Y	20.17 g	N	16.44g	N
Air Bag Sleeve	642.58g	Red Bull Cans	High	(19x15x13.5)[cm]	TBD by Amazon	14.685	4	20.51 g	5	TBD by Amazon	10	yes	18.62 g	Y	8.08g	Y	20.51g	Y	15.37 g	Y
Do Nothing/Current (Cup seal with bubble wrap)	606.68g	Jarritos	Low	(23x5.5x6.5)	TBD by Amazon	9.1825	10	N/A	10	TBD by Amazon	1	No	N/A	N	N/A	N	N/A	N	N/A	N
bubble wrap	614.36g	Jarritos	Medium	(24x7.1x8)[cm]	TBD by Amazon	13.3775	7	N/A	10	TBD by Amazon	1	No	N/A	N	N/A	N	N/A	N	N/A	N
Air Bag Sleeve	635.24g	Jarritos	High	(19x15x13.5)[cm]	TBD by Amazon	16.0825	4	N/A	5	TBD by Amazon	3	No	N/A	Y	N/A	N	N/A	N	N/A	N
Do Nothing/Current (Cup seal with bubble wrap)	384.7kg	Spray Paint Cans	Low	(10x6x6)[cm]	TBD by Amazon	10.0975	10	19.3g	10	TBD by Amazon	7	yes	10.86 g	Y	19.3 g	Y	19.26 g	Y	14.37g	Y
bubble wrap	392.42g	Spray Paint Cans	Medium	(8.4x8x23)[cm]	TBD by Amazon	10.77	7	10.84g	10	TBD by Amazon	8	yes	11.76 g	Y	8.22 g	Y	10.84 g	Y	12.05 g	Y
Air Bag Sleeve	413.33g	Spray Paint Cans	High	(8.5x16x5.5)[cm]	TBD by Amazon	15.925	4	14.6 g	5	TBD by Amazon	10	yes	13.28 g	Y	14.6 g	Y	14.45 g	Y	14.11 g	Y
Do Nothing/Current (Cup seal with bubble wrap)	773.51 g	Pinesol	Low	(10x5.2x5.2)[cm]	TBD by Amazon	9.7475	10	21.93 g	10	TBD by Amazon	10	yes	21.24 g	Y	21.93 g	Y	10.68 g	Y	20.62 g	Y
bubble wrap	782.43g	Pinesol	Medium	(13x7.4x8)[cm]	TBD by Amazon	11.3975	7	24. 37 g	10	TBD by Amazon	10	yes	24.37 g	Y	19.47 g	Y	13.2 g	Y	19.05g	Y
Air Bag Sleeve	803.14 g	Pinesol	High	(13x15x13.5)[cm]	TBD by Amazon	14.7425	4	16.39 g	5	TBD by Amazon	10	yes	16.39 g	Y	16.45 g	Y	14.75 g	Y	16.53g	Y
Do Nothing/Current	203.91 g	Dawn	Low	(4.5x14x24) [CM]	TBD by Amazon	10.66	10	17.37 g	10	TBD by Amazon	10	yes	10.83 g	Y	11.59 g	Y	17.37 g	Y	13.13g	Y
bubble wrap	262.87 g	Dawn	Medium	([x8.5x13]) [cm]	TBD by Amazon	11.315	7	17.32 g	10	TBD by Amazon	10	yes	16.73 g	Y	16.45 g	Y	17.02 g	Y	14.73g	Y
Air Bag Sleeve	281.57 g	Dawn	High	(7.5x 14.5x57) [cm]	TBD by Amazon	16.4875	4	20.2 g	5	TBD by Amazon	10	yes	20.2 g	Y	14.27 g	Y	16.82 g	Y	17.1g	Y

Amazon Drop Test Matrix

FMEA



Testing

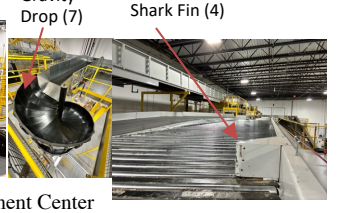
MD9 Fulfillment Center

Drop Test Items

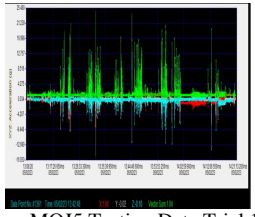
In-house testing with liquid containment

CEM DT-178A 3 Axis Vibration

Drop Test Tubes



MQJ5 Fulfillment Center



MQJ5 Testing Data Trial 1

3 Ft Drop In House Data