

Consumer Aware Warehouse Management SDMay20-25



Advisor: Goce Trajcevski

Client: Jimmy Paul, Crafty LLC. CTO

Team: Lindsey Sleeth, Omair Ijaz, Andrew Smith, Sam Stifter,
Jameel Kelley, Elijah Buscho, Devin Üner

<http://sdmay20-25.sd.ece.iastate.edu/>

Client Background - Lindsey

Crafty LLC helps companies enhance their employees life at work by providing offices with food, beverage, and event management



Project Motivation - Lindsey

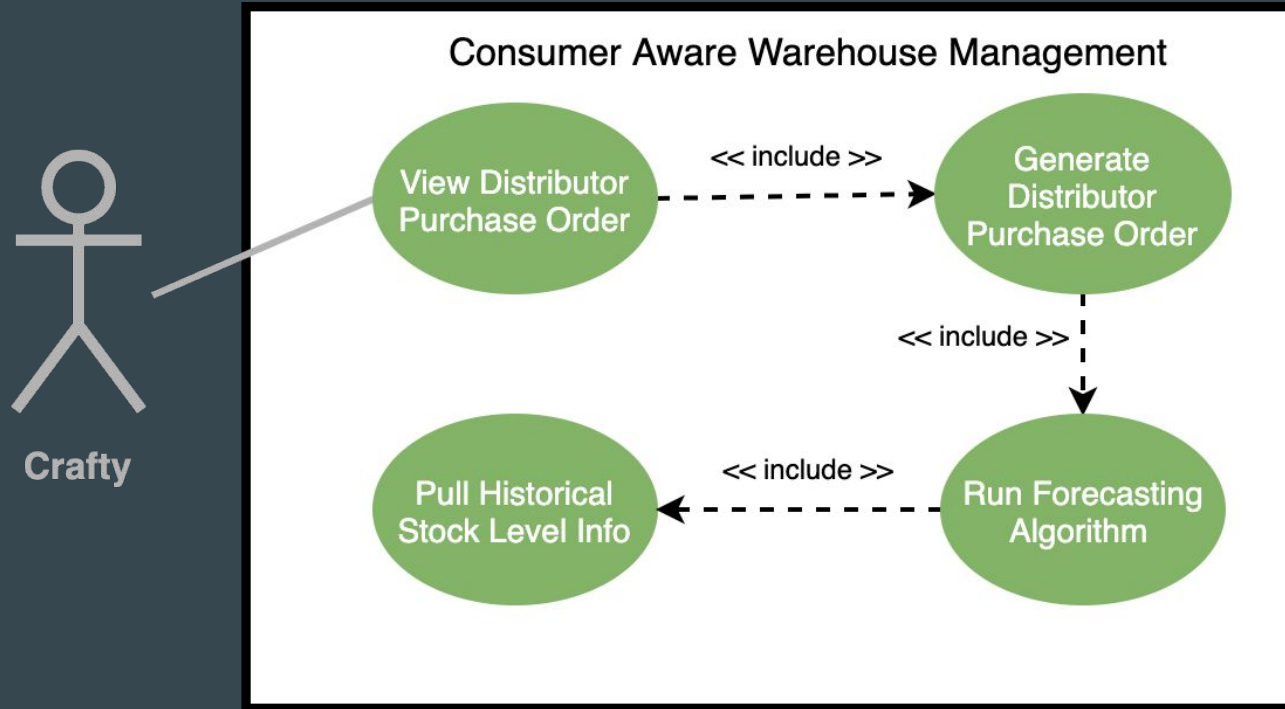
\$600,000 Annually
Missed Revenue for
20,000 Missed Items

\$100,630 Annually
Lost Value for
15,356 Expired Items

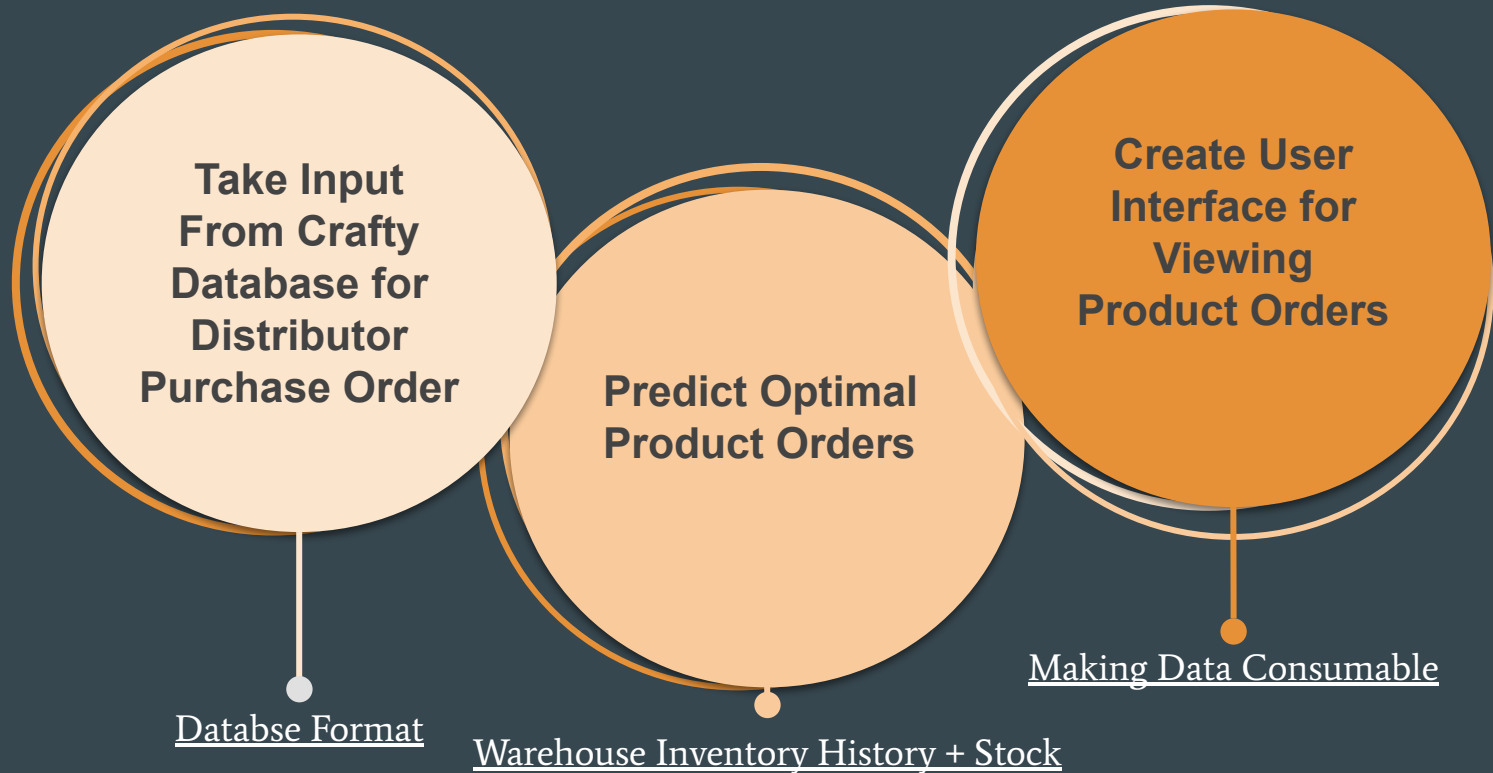
3 Full-Time Employees
Dedicating
50% of Time to Ordering

The **solution** is a **forecasting algorithm** for inventory management that automates reordering for **warehouse stock**

Conceptual Design Diagram - Elijah



Functional Requirements - Jameel



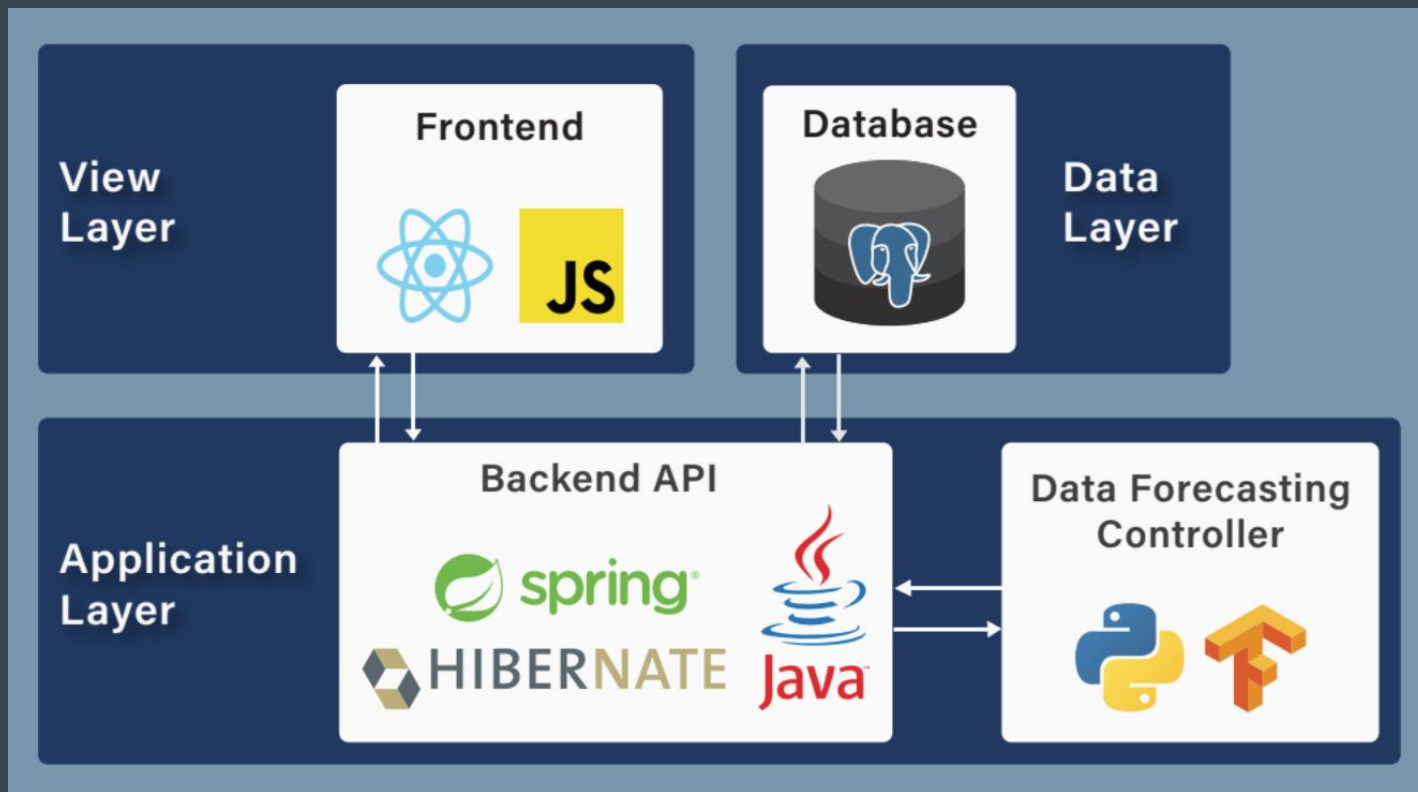
Non-Functional Requirements - Omair

Report Generation in a
Timely Manner

(< 2 min 90% of the time)

Handle 1200 Stock
Keeping Units (SKUs)

System Design - Sam



API Design

API Design - List of All Endpoints - Andrew

Get Distributor

/distributor/{distributorID}

List All Distributors

/distributors/{regionID}

Get All Distributors Order Schedules

/distributors/scheduleAll/{regionID}

Get Distributor Order Schedule

/distributor/schedule/{distributorID}

List All Distributors Ones with Products

/distributors/withProducts/{regionID}

List All Distributors Ones with Products to Order

/distributors/withProductsToOrder/{regionID}

Get Distributors Products

/distributor/products/{distributorID}

Get Distributor Products with Order Quantity >0

/distributor/products/withPredictions/{distributorID}

List All Regions

/regions

Get Breweries

/breweries/{regionID}

List History of Missed Items

/missedItemsBySku/{skuID}

List Historical Warehouse Inventory Level

/sku_hist/{skuID}

Add a New Prediction Value

/predictions/add

Get Predictions for a Sku

/predictions/sku/{skuID}

API Design - Historical Warehouse Inventory Level -Andrew

- Called to get the **historical warehouse inventory level**
- Used to display on a **graph** for frontend
- Used by **algorithm** to generate **predictions**

/sku_hist/{skuID}

```
[
  {
    "createdAt": "2018-04-02T00:30:06.861+0000",
    "count": 51
  },
  {
    "createdAt": "2018-04-02T11:00:10.423+0000",
    "count": 43
  },
  {
    "createdAt": "2018-04-03T11:00:10.828+0000",
    "count": 45
  },
  {
    "createdAt": "2018-04-04T11:00:11.149+0000",
    "count": 46
  }
]
```

API Design - Add a New Prediction Value - Sam

- Make a prediction for **Order Quantity**
- Update the **Database**
- Communicates with the **Machine Learning** Component

/predictions/add

```
{  
  "sku_id": 7291,  
  "qty_to_order": 10  
}
```

API Design - Get Predictions for a Sku - Omair

- All predictions are stored
- The most recent prediction for a SKU can be retrieved DB along with the time stamp
- Will be displayed on the frontend

/predictions/sku/{sku}

```
{  
  "id": 1,  
  "sku_id": 7291,  
  "qty_to_order": 10,  
  "date": "2020-04-06T19:07:09.197"  
}
```

Frontend Design

Crafty's System - Lindsey

CRAFTY Account/Company Product Order Logout

Procurement Management

← back

Procurement Tool Distributor Order List Placed Order List

Region
Chicago

Distributor
CHI - Costco - Business

1
2

85	Costco - Business							Order Minimum	Term	Buffer	
Order Method: Email, procurement@craftydelivers.com, w580mkm@costco.com, w580mkm04@costco.com, w580mkm03@costco.com, w580mkm10@costco.com 7300 S Cicero Ave, Bedford Park, IL 60629							Active: M, W, Th Order Due @: 2:30 PM		\$229.44/ \$ 250.00	4	1.4 x
Distributor Product ID External ID	Cost Price	Product Info	Reorder Threshold Units	Order Up To Units	OH Inventory (Base Units)	On Hand Units En Route	Amount Needed	Amount To Order	Order Spend	Missed Item Count	Order Stats
<input type="checkbox"/> 21681 212858	\$ 6.29 \$ 9.99	Extra Fancy Long Grain White Rice C&F Foods 10 lb bag	1.0	3.0	1 (1)	0	2	2	\$ 12.58	0	?
<input type="checkbox"/> 13993 921389	\$ 14.09 \$ 21.99	Smart Zip Quart Freezer Bag Ziploc 216 - 1 qt bags	1.0	2.0	1 (1)	0	1	1	\$ 14.09	0	?
<input type="checkbox"/> 32145 1335941	\$ 14.49 \$ 22.50	Variety Pack Hubert's Lemonade 12 - 16 oz bottles	2.0	5.0	2 (2)	0	3	3	\$ 43.47	0	?
<input type="checkbox"/> 7840 1079506	\$ 13.65 \$ 19.99	Dried Mango Paradise Green 35.2 oz bag	2.0	4.0	1 (1)	0	3	3	\$ 40.95	0	?
<input type="checkbox"/> 7870 516452	\$ 9.89 \$ 14.99	Mini Moo's Half & Half Creamer Cups Land O'Lakes 192 - 0.9 oz cups	2.0	3.0	2 (2)	0	1	1	\$ 9.89	0	?
<input type="checkbox"/> 7949 95956	\$ 15.89 \$ 28.00	Peanut Butter M&M's M&M'S 24 - 1.6 oz bags	3.0	5.0	3 (3)	0	2	2	\$ 31.78	0	?

3
4

Demo - Lindsey

Procurement Tool **Purchase Order Table**

Chicago 189 Showing: 1 / 1 Distributors [Edit Filters](#) [Clear Filters](#)

189. TeaSquares

Order Days: M, T, W, Th, F Buffer: 1 Order Min: -
Term: 4 Week Basis: 1 Days To Delivery: 14
Days To Delivery End: 21

6 Products [Show Empty Products](#)

SKU	Distributor Base SKU	Name	Brand	Size Name	Cost Per Unit	OH Inventory Target Level	Quantity to Order	Purchase Cost
- 8078	8078	Acai Blueberry Tea	TeaSquares	16.0 - 0.7 oz packs	\$16	0	10	\$160

Order History Level

The chart displays 'Product Stock' as a blue line with diamond markers and 'Missed Orders' as red dots. The y-axis ranges from 8 to 10. The stock starts at 10, drops to 9, then to 8. It then rises to 10, drops to 9, then to 8, and finally to 7. Missed orders are indicated by red dots at the 8 and 7 levels.

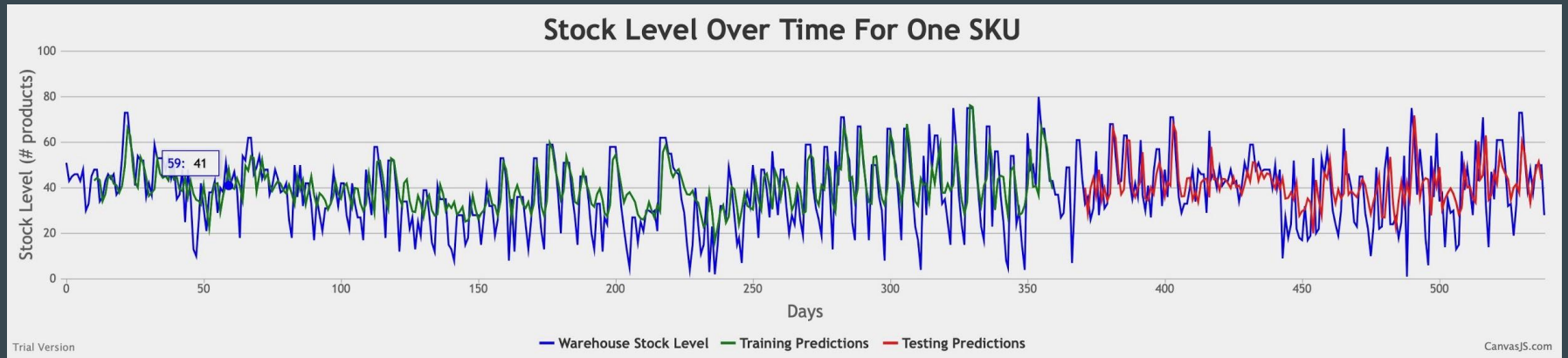
[Link](#)

Machine Learning Design

Machine Learning Design - Devin

- Long Short Term Memory (LSTM) neural network
- Capable of predicting long term and short term trends in data
- Created with Keras and Tensorflow

Algorithm Test Plan - Devin



Test Plan - Algorithm - Elijah

- Test SKUs
- Missed Sales
- Client Order History

Test Plan

Frontend - Jameel

- Manual testing of components upon completion
- Using Postman Collection to check API status and return values
- Using Developer Tools to test XHR Requests (time and deserialization to objects)

Backend - Sam

- Manual Tests
 - Create SQL Queries
 - Create Spring Endpoints
 - Compare Endpoint results with SQL results
- CI/CD
 - Compile and Deploy to Server

Engineering Standards and Design Practices - Sam

- Code Review
- Xtreme Programming
- Model View Controller

Lessons Learned - Everyone

- Backend - Omair
 - PostgreSQL databases
 - Working with existing databases can be very difficult to find where and what the data is
 - Complex queries with Spring
 - API design to support a flexible frontend
 - Planning and task distribution is important
- Frontend
 - React Framework
 - API Integration
 - Robust API Integration on Frontend
 - Peer Programming while Teaching
- Algorithm
 - Working with LSTM neural networks
 - Using Tensorflow and Keras
 - Data is important
 - Amount of data
 - Knowledge of data

Thank you!

Questions?


Existing Approaches 1 (Learning Based Approach)

- Input Variables
 - Past Sales
 - Weather
 - Travel Time of Product
- Advantages
 - Better Prediction of Demand
 - Lowers Missed Sales
- Disadvantages
 - Amount of Resources
- Relation to Our Solution
 - Past Sales Data
 - Shipping Time
- Differentiation From Our Solution
 - Too Many Input Variables

Existing Approaches 2 (Regression Based Approach)

- Input Variables
 - Past Sales
 - Seasonal Changes
- Advantages
 - Little Amount of Resources
- Disadvantages
 - Can't Handle Spikes in Demand
 - Doesn't Figure in Shipping Time
- Relation to Our Solution
 - Past Sales Data
- Differentiation From Our Solution
 - Doesn't Figure in Shipping Time

Distributor Order List

Logout

Procurement Management


[← back](#)

Procurement Tool
Distributor Order List
Placed Order List

Order Day
Saturday

Search:

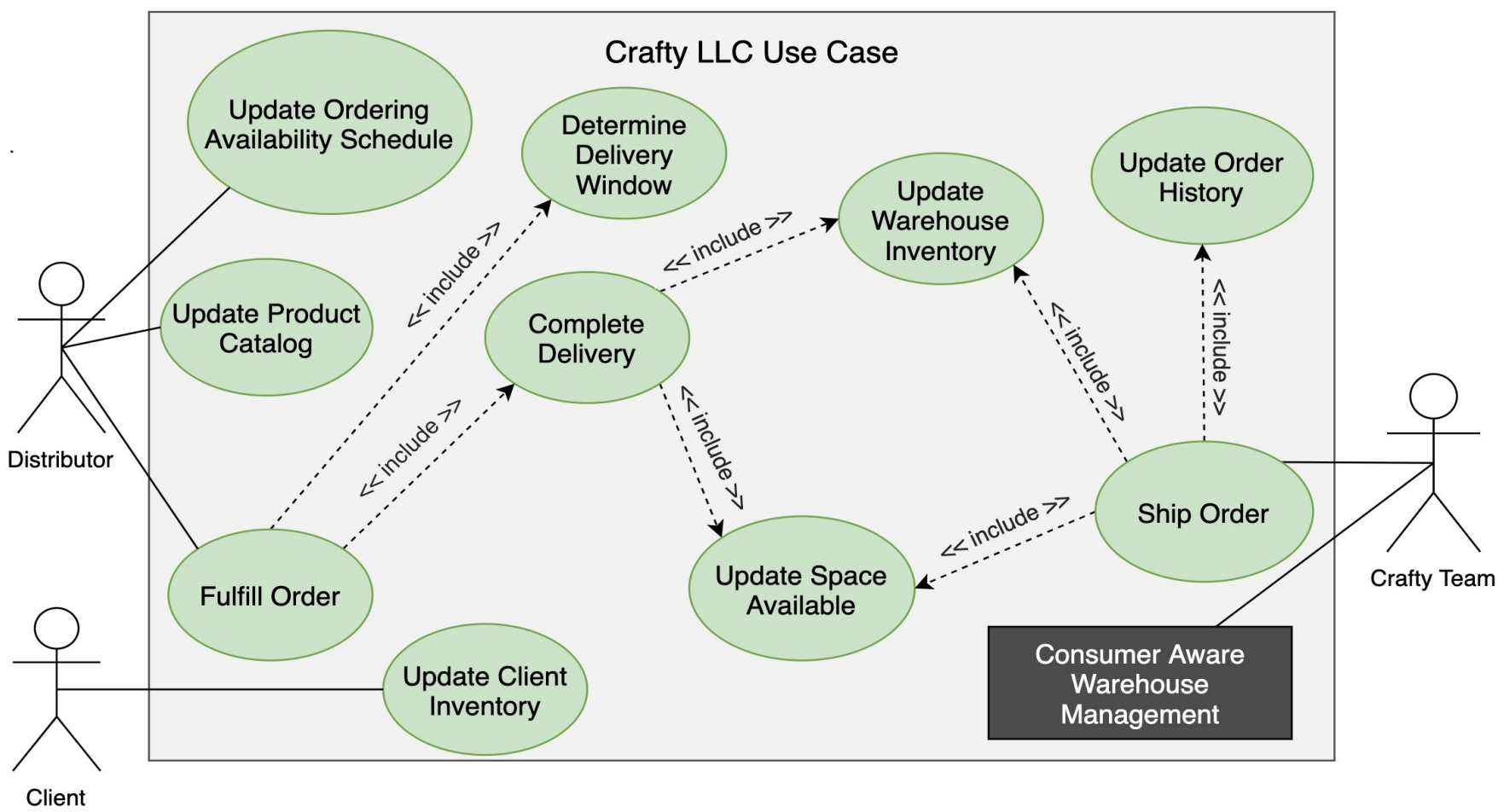
Place Order	Distributor	Region ▼	Order Days	Order Due Time	Purchaser	Order Method	Ignore	Order Created?
+	Amazon	CHI	M, T, W, Th, F, Sa, Su	12:00 PM	Jessica Huang	Online	<input type="checkbox"/>	
+	Samantha's Event Linens	CHI	M, T, W, Th, F, Sa, Su		Jessica Huang	Email	<input type="checkbox"/>	
+	415 Catering	SF	M, T, W, Th, F, Sa, Su				<input type="checkbox"/>	
+	Cheffield Events	CHI	M, T, W, Th, F, Sa, Su		Kevin Binder	Email	<input type="checkbox"/>	
+	Aloha Poke	CHI	M, T, W, Th, F, Sa, Su			Email	<input type="checkbox"/>	
+	Crafty	SF	M, T, W, Th, F, Sa, Su				<input type="checkbox"/>	
+	Herbs & Spices Catering	SF	M, T, W, Th, F, Sa, Su				<input type="checkbox"/>	
+	DOUGH XX	SF	M, T, W, Th, F, Sa, Su		Jessica Huang		<input type="checkbox"/>	
+	Just Salad	CHI	M, T, W, Th, F, Sa, Su				<input type="checkbox"/>	
+	Protein Bar & Kitchen	CHI	M, T, W, Th, F, Sa, Su				<input type="checkbox"/>	
+	Safeway - Oakland	SF	M, T, W, Th, F, Sa, Su		Jessica Huang	Online	<input type="checkbox"/>	
+	411 Catering	CHI	M, T, W, Th, F, Sa, Su				<input type="checkbox"/>	



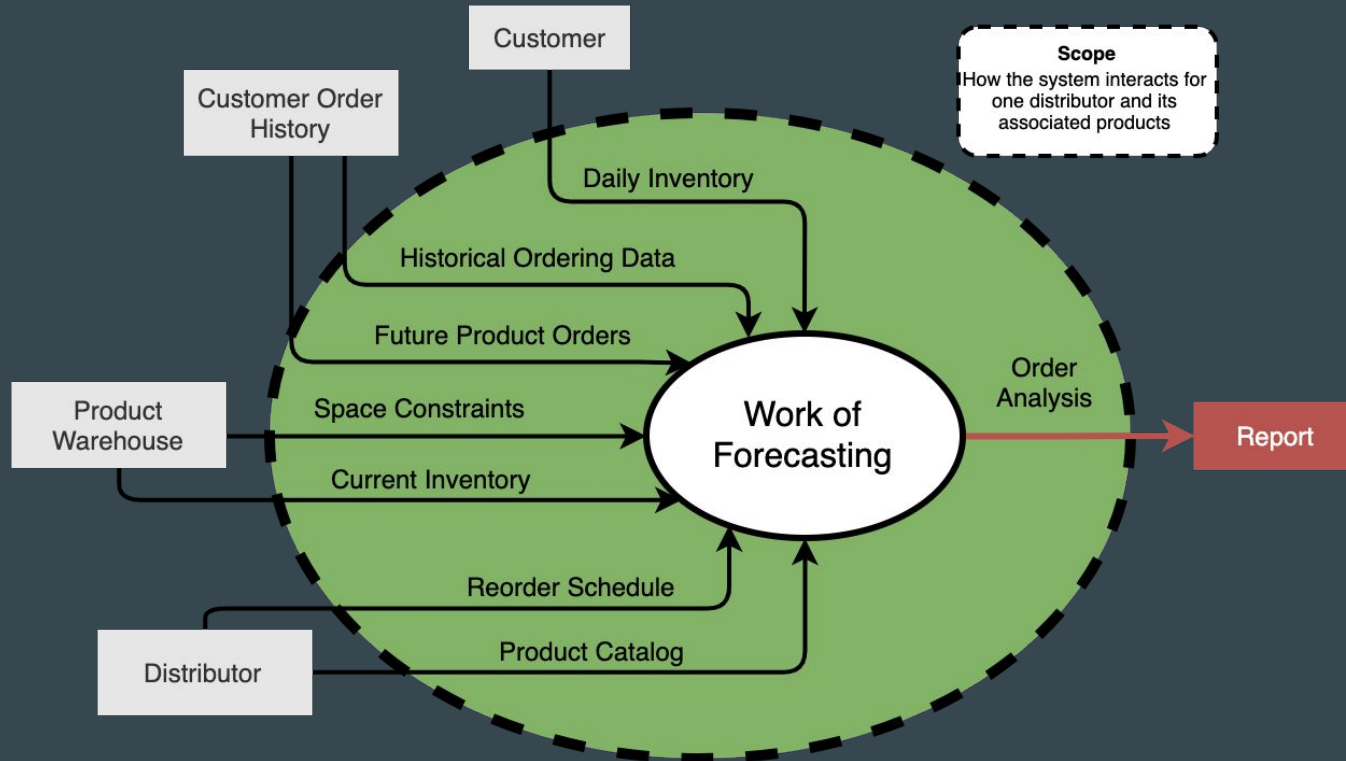
Implementation

		Chicago					Bartend Chicago				
12		Bartend Chicago					Order Minimum		Term	Buffer	
		Order Method: Active: M, T, W, TH, F,									
		Address: Order Due:									
Distributor	Cost	Product Info	Reorder Threshold Units	Order Up To Units	OH Inventory (Base Units)	On Hand Units En Route	\$/\$1			1 x	
ProductID	---						Amount Needed	Amount To Order	Order Spend	Missed Item Count	Order Stats
ExernalID	Price										
<input type="checkbox"/> 21681	\$ 6.29	Extra Fancy Long Grain White Rice	<input type="text" value="1"/>	<input type="text" value="3"/>	1(1)	0	2	<input type="text" value="2"/>	\$12.58	0	i
212858	\$ 9.99										
<input type="checkbox"/> 13993	\$ 14.09	Smart Zip Quart Freezer Bag	<input type="text" value="1"/>	<input type="text" value="2"/>	1(1)	0	1	<input type="text" value="1"/>	\$14.09	0	i
921389	\$ 21.99										

Crafty LLC Use Case



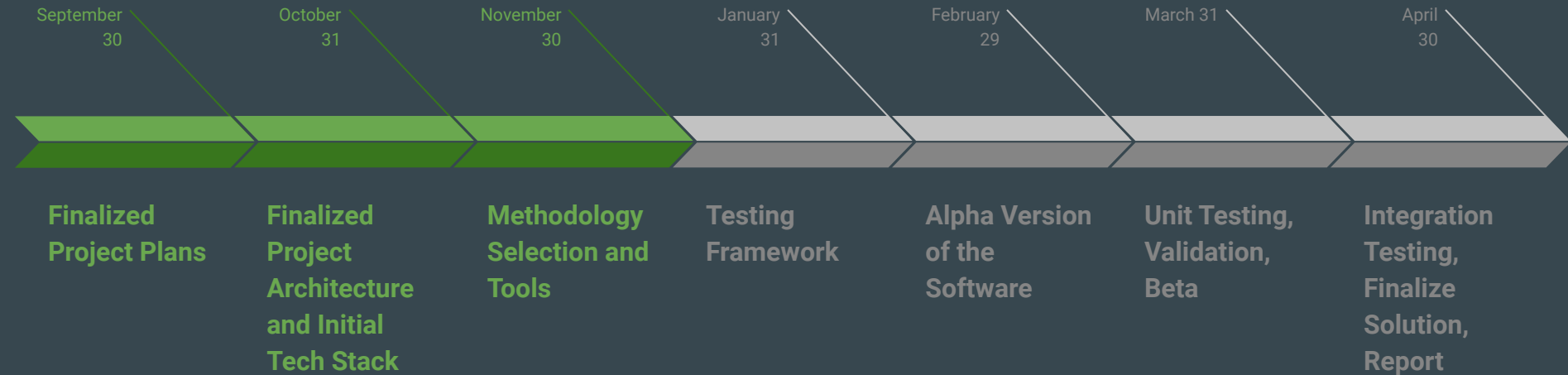
Conceptual Sketch



Project Plan - Tasks



Project Plan - Schedule / Milestones



Project Plan - Risks

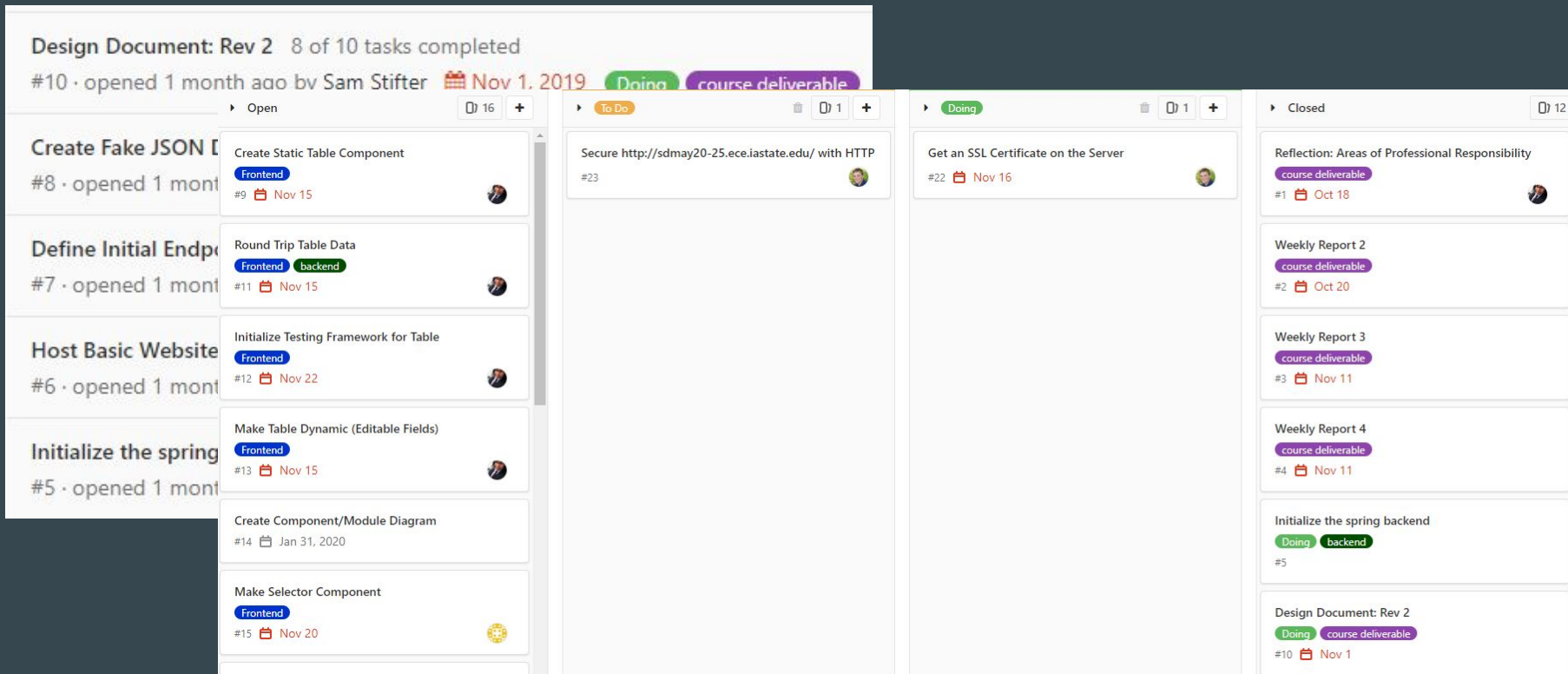
Inaccurate results

Results not clearly understood

Steep learning curve

		Impact		
		Minor	Moderate	Severe
Likelihood	Very Likely	Medium	High	High
	Likely	Low	High	High
	Possible	Low	Medium	High
	Unlikely	Low	Medium	Medium
	Very Unlikely	Low	Medium	Medium

Project Plan - Progress Metrics



Project Vision - Lindsey

Crafty desires a forecasting algorithm for inventory management that automates reordering for warehouse stock

