

# Inventory Planning: A New Look at the Safety Stock Process

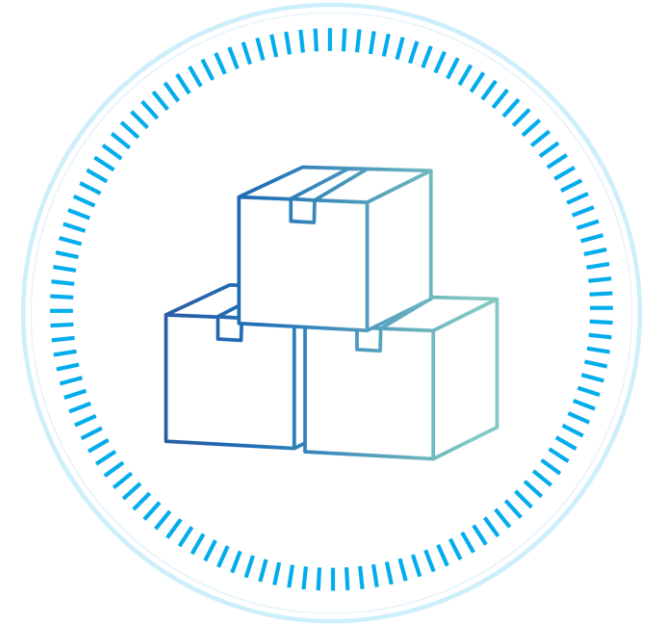
Fred Tolbert  
Demand Solutions Southeast

**velocity**  
CONNECT + ACCELERATE + INNOVATE



# Functions of Inventory – Why Hold Inventory?

- ▶ To meet customer demand (cycle stock):
  - Immediately fill customer orders
  - Customers expect us to fill orders faster than it takes to make or purchase
  - Deploy the product / material where it will be used
- ▶ To buffer against uncertainty in demand / supply (safety stock):
  - Uncertainty in demand: sales or usage above expectations
  - Uncertainty in supply: shortages, delays, disruptions
- ▶ To decouple supply from demand (strategic stock):
  - Supply pattern is different from demand pattern
    - ▶ Achieve economies of scale in purchasing; take advantage of volume price breaks/discounts
    - ▶ Speculative buying in anticipation of price increase
    - ▶ Economical order size, lot size, production output
    - ▶ Seasonal products / demand



## Functions of Inventory – Why Hold Inventory?

- ▶ The big question is:

**How much safety stock inventory should we keep to maintain our desired level of customer service?**

## Typical Inventory Policy

**“We want to keep a 3 month supply of every item.”**

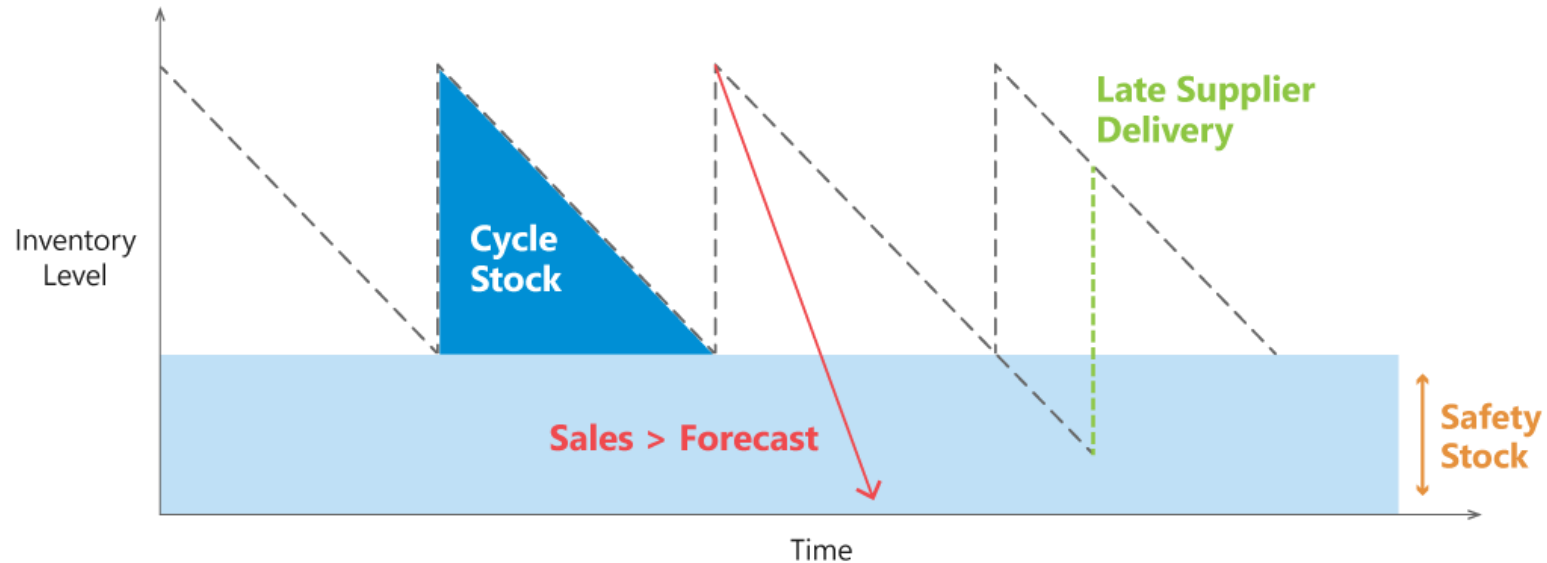
**or**

**“We want to keep 100 units of our A items.”**

- ▶ This approach is easy to implement, but does it work?

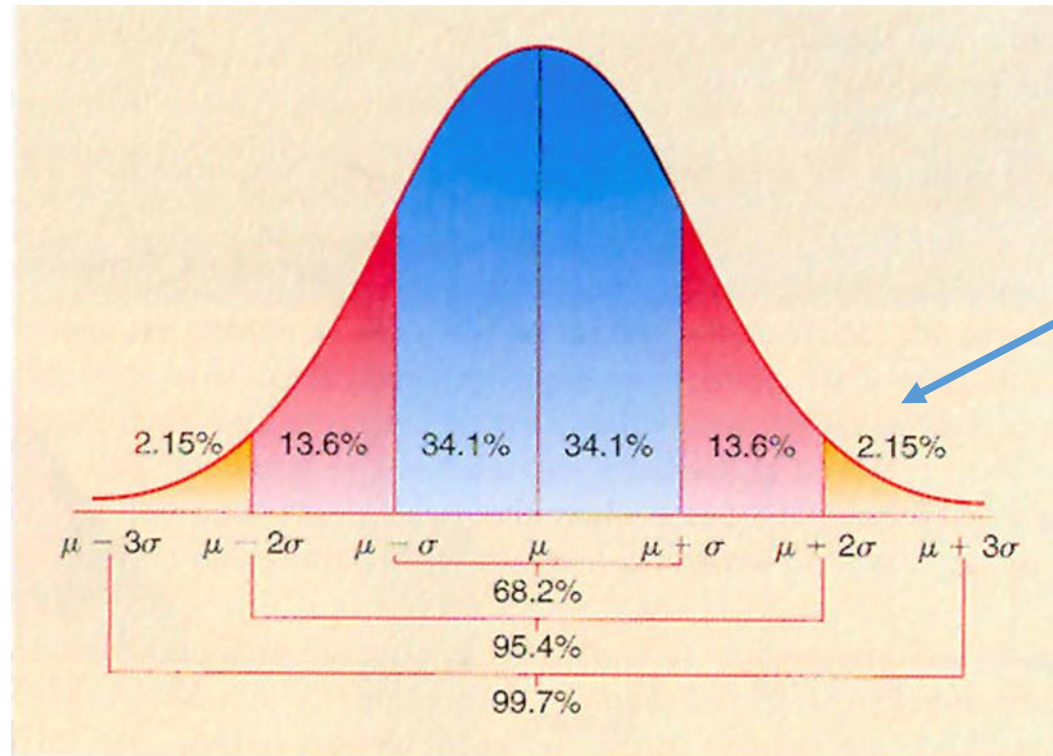
# Inventory Management Rule of Thumb

- ▶ The higher the variability of demand, the higher the safety stock required to maintain a given level of service.
- ▶ Two methods of Safety Stock Management:
  - Safety stock – expressed in static units – 100 units of safety stock
  - Safety time – expressed in periods of supply – 2 months of forecasted demand



## Traditional Safety Stock Theory

- ▶ Calculation is the statistical probability of a stockout
- ▶ Uses a service level factor to compute the likelihood of forecast variance > average variance
- ▶ Computes a safety stock quantity to cover a specific service level



Standard deviation from the mean gives us the % probability of an abnormal demand

# DS has a Powerful Inventory Planning Optimizer

01275801 CA-NONE-HL - Velocity - 2019    Inventory Planning - 01275801 CA-NONE-HL \*

Demand Field: Adjusted History    Periods: Specify    12

Forecast Field: Adjusted Forecast    Periods: 12

Table to Use: DMI    Target Rate: 98.00

Multiply By: Nothing    1.00

Highest Variance Spike Levelled: 0

Calculate

Calculation	Safety Stock	Safety Time	IP Turns
<input type="radio"/> Forecast Error STD	344.67	4.70	2.31
<input checked="" type="radio"/> Forecast Error Optimizer	180.00	2.45	4.06
<input type="radio"/> Average Demand	115.00	0.32	14.59
<input type="radio"/> Percent Total Demand	472.00	1.32	0.00
<input type="radio"/> Percent Demand Filled	548.00	1.54	0.00

01275801 CA-NONE-HL - Velocity - 2019    Inventory Planning - 01275801 CA-NONE-HL \*

Filter Region: [ ] -- [ ]    Apply Filter    Undo Filter     Show Fiscal

Excel Version: Excel 2013    Export to Excel    Print Preview    Print

Totals and/or averages only reflects displayed periods.     Totals and/or averages reflect all periods.

	September	October	November	December	January	February	March	April	May	June	July	August	Total
Adjusted Forecast (15-16)	258	188	364	332	205	266	315	342	519	414	751	258	4,212
Adjusted History (15-16)	365	221	197	311	419	378	548	480	423	270	378	291	4,281
Variance	-107.00	-33.00	167.00	21.00	-214.00	-112.00	-233.00	-138.00	96.00	144.00	373.00	-33.00	-69.00

# Safety Stock Formula 1: Forecast Error Using Standard Deviation

- ▶ **Definition:** Common Technique which uses the standard deviation of forecast errors and a desired service level factor to compute safety stock units.
- ▶ **Calculation:**
  - Calculate the absolute variance between Forecast and Demand (Forecast – Actual).
  - Sum the absolute variance values.
  - Divide the total absolute variance by the number of months selected. This value is the absolute variance or “mean error.”
  - Calculate the deviation for each month (Average Variance – Absolute Variance)
  - Square each monthly deviation.
  - Total the squared values.
  - Divide the sum of the squared deviations by the number of months minus 1.
  - Using the value found in Step 7, calculate the square root.
  - Multiply the square root by the service factor that is associated with the target service level chosen (for 95% service, the service factor is 1.64).
  - Add this value to the mean error from Step 3. This value is the safety stock to provide 95% coverage.
- ▶ **Result assumes a one month forecast interval and one month lead time. Multiply the result by the square root of the lead time to adjust for different lead times.**



# Safety Stock Formula 1: Forecast Error Using Standard Deviation

Item: A101 CUST006							
	Demand	Forecast	Variance	Absolute Variance	Average Variance	Deviation	Squared Deviation
Month 12	365	258	-107	107	139.25	-32.25	1,040.06
Month 11	221	188	-33	33	139.25	-106.25	11,289.06
Month 10	197	364	167	167	139.25	27.75	770.06
Month 9	311	332	21	21	139.25	-118.25	13,983.06
Month 8	419	205	-214	214	139.25	74.75	5,587.56
Month 7	378	266	-112	112	139.25	-27.25	742.56
Month 6	548	315	-233	233	139.25	93.75	8,789.06
Month 5	480	342	-138	138	139.25	-1.25	1.56
Month 4	423	519	96	96	139.25	-43.25	1,870.56
Month 3	270	414	144	144	139.25	4.75	22.56
Month 2	378	751	373	373	139.25	233.75	54,639.06
Month 1	291	258	-33	33	139.25	-106.25	11,289.06
			Total Variance	1,671		Sum Squared Deviations	110,024.25
			Avg Variance	139.25		Divide by N-1 (11)	10,002.20
						Squart Root	100.01
						Service Factor - 98%	2.05
						Service Factor Qty	205
						Add Average Deviation	139
						DS Safety Stock Units	<u>345</u>

# Safety Stock Formula 1: Forecast Error Using Standard Deviation

## ► Recommended usage:

- Not highly recommended safety stock calculation technique, due to inherent limitations in the standard deviation calculation
  - Due to absolute value calculation, the standard deviation calculates safety stock even for periods where the forecast exceeded actual demand
  - Standard deviation technique is based on the standard probability of stockout, not the value required to obtain a certain level of demand coverage
  - Calculated value will always be greater than the Forecast Error Optimizer calculation.

01275801 CA-NONE-HL - Velocity - 2019 Inventory Planning - 01275801 CA-NONE-HL \*

Demand Field	Adjusted History	Periods	Specify	12
Forecast Field	Adjusted Forecast	Periods	12	
Table to Use	DMI	Target Rate	98.00	
Multiply By	Nothing		1.00	
Highest Variance Spike Levelled	0			

Calculate

Calculation	Safety Stock	Safety Time	IP Turns
<input type="radio"/> Forecast Error STD	344.67	4.70	2.31
<input checked="" type="radio"/> Forecast Error Optimizer	180.00	2.45	4.06
<input type="radio"/> Average Demand	115.00	0.32	14.59
<input type="radio"/> Percent Total Demand	472.00	1.32	0.00
<input type="radio"/> Percent Demand Filled	548.00	1.54	0.00

## Safety Stock Calculation 2: Forecast Error Optimizer

- ▶ **Definition:** Calculates safety stock using a reiterative calculation technique, how much safety stock to add to the forecast in order to cover the desired percentage of demand.
- ▶ **Calculation:**
  - Calculate how percentage of demand is covered by the forecast with no safety stock.
  - Determine the desired service level (such as 95%). If the desired service level is greater than the actual service level, safety stock is needed.
  - Add 1 unit to the safety stock and add to the forecast. Calculate the % coverage.
  - If the coverage is still below the service level target, repeat Step 3.
  - Result is the safety stock in units required to provide the desired percentage of demand.
- ▶ **Result** assumes a one month forecast interval and one month lead time. Multiply the result by the square root of the lead time to adjust for different lead times.

# Safety Stock Formula 2: Forecast Error Using Service Level Optimizer

Forecast Error Using Service Level Optimizer					
			Optimizer		
Item: A101 CUST006				Safety Stock:	180
	Demand	Forecast	Shortfall (wo/SS)	Forecast + Optimizer	Net Shortfall (w/SS)
Month 12	365	258	107	438	
Month 11	221	188	33	368	
Month 10	197	364		544	
Month 9	311	332		512	
Month 8	419	205	214	385	34
Month 7	378	266	112	446	
Month 6	548	315	233	495	53
Month 5	480	342	138	522	
Month 4	423	519		699	
Month 3	270	414		594	
Month 2	378	751		931	
Month 1	291	258	33	438	
	4281	4212	870		87
	4195		79.7% <== Service Level ==>		98.0%

# Safety Stock Formula 2: Forecast Error Optimizer

## ► Recommended usage:

- Recommended safety stock technique. Assumes that the forecasts from previous periods have been saved.
- Set service level targets by ABC class, such as:
  - A items = 98%
  - B items = 95%

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Demand Field	Adjusted History	Periods	Specify	12
Forecast Field	Adjusted Forecast	Periods	12	
Table to Use	DMI	Target Rate	98.00	
Multiply By	Nothing		1.00	
Highest Variance Spike Levelled	0			Calculate

Calculation	Safety Stock	Safety Time	IP Turns
<input type="radio"/> Forecast Error STD	344.67	4.70	2.31
<input checked="" type="radio"/> Forecast Error Optimizer	180.00	2.45	4.06
<input type="radio"/> Average Demand	115.00	0.32	14.59
<input type="radio"/> Percent Total Demand	472.00	1.32	0.00
<input type="radio"/> Percent Demand Filled	548.00	1.54	0.00

## Safety Stock Formula 3: Forecast Error Using Average Demand as Forecast

- ▶ Definition: Same calculation as Formula 2, except Average Demand is used as sales forecast
- ▶ Calculates safety stock using a reiterative calculation technique, how much safety stock to add to the forecast in order to cover the desired percentage of demand.
- ▶ Calculation:
  - Calculate how percentage of demand is covered by the forecast with no safety stock.
  - Determine the desired service level (such as 95%). If the desired service level is greater than the actual service level, safety stock is needed.
  - Add 1 unit to the safety stock and add to the forecast. Calculate the % coverage.
  - If the coverage is still below the service level target, repeat Step 3.
  - Result is the safety stock in units required to provide the desired percentage of demand.
- ▶ Result assumes a one month forecast interval and one month lead time. Multiply the result by the square root of the lead time to adjust for different times.

# Safety Stock Formula 3: Forecast Error Using Average Demand as Forecast

Average Demand as Forecast					
		Optimizer			
Item: A101 CUST006		Safety Stock:		114	
	Demand	Forecast	Shortfall (wo/SS)	Forecast + Optimizer	Net Shortfall (w/SS)
Month 12	365	357	8	471	
Month 11	221	357		471	
Month 10	197	357		471	
Month 9	311	357		471	
Month 8	419	357	62	471	
Month 7	378	357	21	471	
Month 6	548	357	191	471	77
Month 5	480	357	123	471	9
Month 4	423	357	66	471	
Month 3	270	357		471	
Month 2	378	357	21	471	
Month 1	291	357		471	
	4281	4281	494		87
Avg Demand	357		88.5% <== Service Level ==>		98.0%

# Safety Stock Formula 3: Forecast Error Using Average Demand as Forecast

## ► Recommended usage:

- Used when the forecasts from previous periods have not been used
- Set service level targets by ABC class, such as:
  - A items = 98%
  - B items = 95%
  - C items = 90%

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Demand Field: Adjusted History    Periods: Specify    12  
 Forecast Field: Adjusted Forecast    Periods: 12  
 Table to Use: DMI    Target Rate: 98.00  
 Multiply By: Nothing    1.00  
 Highest Variance Spike Levelled: 0

Calculate

Calculation	Safety Stock	Safety Time	IP Turns
<input type="radio"/> Forecast Error STD	344.67	4.70	2.31
<input checked="" type="radio"/> Forecast Error Optimizer	180.00	2.45	4.06
<input type="radio"/> Average Demand	115.00	0.32	14.59
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<input type="radio"/> Percent Demand Filled	548.00	1.54	0.00



## Safety Stock Formula 4: % Total Demand – No Forecast

- ▶ **Definition:** This method does not look at forecast error, nor does it use average demand as a baseline.
- ▶ It very simply calculates a total stocking level that would have satisfied the specified percentage of demand over the selected period.

# Safety Stock Formula 4: % Total Demand – No Forecast

Average Demand as Forecast					
Item: A101 CUST006		Optimizer			
		Safety Stock:		471	
	Demand	Forecast	Shortfall (wo/SS)	Forecast + Optimizer	Net Shortfall (w/SS)
Month 12	365	357	8	471	
Month 11	221	357		471	
Month 10	197	357		471	
Month 9	311	357		471	
Month 8	419	357	62	471	
Month 7	378	357	21	471	
Month 6	548	357	191	471	77
Month 5	480	357	123	471	9
Month 4	423	357	66	471	
Month 3	270	357		471	
Month 2	378	357	21	471	
Month 1	291	357		471	
	4281	4281	494		87
Avg Demand	357		88.5% <== Service Level ==>		98.0%

# Safety Stock Formula 4: % Total Demand – No Forecast

► Recommended usage:

- Use this technique if:
  - You do not have saved forecasts
  - Forecasts have proved to be highly inaccurate or demand variability is very high
- Use this safety stock value in a min / max replenishment technique. Do not use with a sales forecast.

The screenshot shows a software window titled "Inventory Planning - 01275801 CA-NONE-HL \*". It contains several input fields and a table of results.

Input fields include:

- Demand Field: Adjusted History
- Forecast Field: Adjusted Forecast
- Table to Use: DMI
- Multiply By: Nothing
- Highest Variance Spike Levelled: 0
- Periods (top right): Specify, 12
- Periods (middle right): 12
- Target Rate: 98.00
- Target Rate (bottom middle): 1.00

A "Calculate" button is located on the right side of the input fields.

Below the input fields is a table with the following data:

Calculation	Safety Stock	Safety Time	IP Turns
<input type="radio"/> Forecast Error STD	344.67	4.70	2.31
<input checked="" type="radio"/> Forecast Error Optimizer	180.00	2.45	4.06
<input type="radio"/> Average Demand	115.00	0.32	14.59
<input type="radio"/> Percent Total Demand	472.00	1.32	0.00
<input type="radio"/> Percent Demand Filled	548.00	1.54	0.00

## Safety Stock Formula 5: % Demand Periods Filled 100%

- ▶ **Definition:** This method is very similar to Percent of Total Demand, with one exception. The specified target service level is interpreted to mean percent of periods totally covered, not percent of total demand covered.

## Safety Stock Formula 5: % Demand Periods Filled 100%

### ► Recommended usage:

- Use this technique if:
  - You do not have saved forecasts
  - Forecasts have proven to be highly inaccurate or demand variability is very high
- Use this safety stock value in a min / max replenishment technique. Do not use with a sales forecast.

# Safety Stock Formula 5 – % Demand Periods Filled 100%

% Demand Periods Filled 100%					
			Optimizer		
Item: A101 CUST006			Safety Stock: 548		
	Demand	Forecast	Shortfall (wo/SS)	Forecast + Optimizer	Net Shortfall (w/SS)
Month 12	365	0	365	548	
Month 11	221	0	221	548	
Month 10	197	0	197	548	
Month 9	311	0	311	548	
Month 8	419	0	419	548	
Month 7	378	0	378	548	
Month 6	548	0	548	548	
Month 5	480	0	480	548	
Month 4	423	0	423	548	
Month 3	270	0	270	548	
Month 2	378	0	378	548	
Month 1	291	0	291	548	
	4281	0	4281		0
Avg Demand	357		0.0% <== Service Level ==>		100.0%

# Safety Stock Formula 5: % Demand Periods Filled 100%

## ► Recommended usage:

- Use this technique if:
  - You do not have saved forecasts
  - Forecasts have proved to be highly inaccurate or demand variability is very high
- Use this safety stock value in a min / max replenishment technique. Do not use with a sales forecast.

01275801 CA-NONE-HL - Velocity - 2019    Inventory Planning - 01275801 CA-NONE-HL \*

Demand Field: Adjusted History    Periods: Specify    12  
 Forecast Field: Adjusted Forecast    Periods: 12  
 Table to Use: DMI    Target Rate: 98.00  
 Multiply By: Nothing    1.00  
 Highest Variance Spike Levelled: 0

Calculate

Calculation	Safety Stock	Safety Time	IP Turns
<input type="radio"/> Forecast Error STD	344.67	4.70	2.31
<input checked="" type="radio"/> Forecast Error Optimizer	180.00	2.45	4.06
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<input type="radio"/> Percent Demand Filled	548.00	1.54	0.00

## Develop a Safety Stock Strategy – Don't Be Lamar

*“Fred, you just don't understand. We sell to Home Depot. It's just as bad to stock out of a C item as an A item.”*

~ Lamar, VP Logistics

- ▶ Used that rational to manage “C” items with the same techniques as “A” items.
- ▶ You can't manage “A” items and “C” items the same way.
- ▶ Guaranteed to have too much of one or not enough of the other.



## Develop a Safety Stock Strategy

- ▶ Many companies set the same service level for all items, regardless of ABC classification.
- ▶ Instead, use a strategy such as:
  - “A” items – 98% service level
  - “B” items – 95% service level
  - “C” items – 90% service level

**How do you do it?**

# QUESTIONS?

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THANK YOU