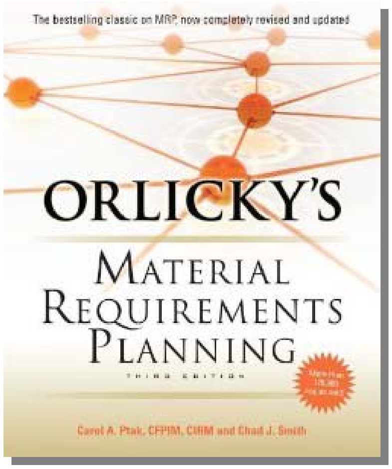
Demand Driven MRP

Replenishment Positions vs. Safety Stock

Why are they so different?

Carol Ptak and Chad Smith

Demand Driven MRP (DDMRP) is the formal planning and execution solution for the 21st Century introduced in the new Orlicky's Material Requirements Planning that provides the ability to sense, adapt and serve today's highly volatile and complex demand chains. The DDMRP method replaces the previous convention of Safety Stock with strategically replenished positions that decouple the supply chain and compress lead time response. This position paper will detail the dramatic differences between these two approaches. This paper introduces new verbalizations and graphical depictions and should be treated as a supplement to the book.



"Sir, please do not smoke around the fuel pumps."
"It's OK, I brought my fire extinguisher."

Demand Driven INSTITUTE

September 2011

www.demanddriveninstitute.com

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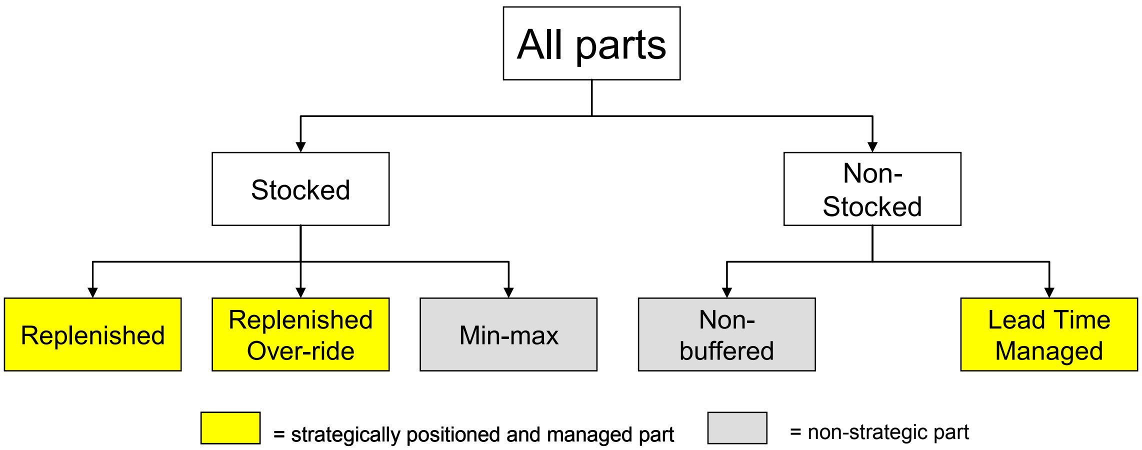
In the newest edition of Orlicky's Material Requirements Planning the new rules for formal planning and related execution called Demand Driven MRP (DDMRP) are introduced. A key change from traditional MRP is the elimination of Safety Stock. You may be asking "What is the difference between safety stock and these replenished positions you advocate?" Below is a chart that summarizes part classification types in DDMRP. This position paper will focus on the difference between replenished positions and the conventional safety stock notion.



What is Safety Stock?

The APICS dictionary provides an excellent definition for safety stock:

> *1) In general, a quantity of stock planned to be in inventory to protect against fluctuations in demand or supply. 2) In the context of master production scheduling, the additional inventory and capacity planned as protection against forecast errors and short-term changes in the backlog. Over-planning can be used to create safety stock.*[1]

This definition clearly describes that safety stock is a supplementary position to guard only against variation. Consider the dramatic increase in variation across every supply chain as complexity increases worldwide. Combine this fact with working capital reduction mandates and planners are now finding themselves in a huge conflict. If forecast error is high then the safety stock supplementary position can become quite an extraordinary financial commitment to statistically cover that error.

Safety Stock	Replenishment
A **supplementary** inventory position designed to make up for misalignments between planned orders, actual demand and supply orders	Are **strategic and primary** inventory position designed to decouple areas in order to compress lead times and dampen variability

[1] APICS dictionary 12th edition, Blackstone 2010

Replenishment positions, however, are strategic and primary in nature. Replenishment positions are put into place with the idea of stopping or preventing the amplification and the impact of variation instead of reacting after it happens like safety stock does. It is similar to the difference between the notions of a firewall versus a fire extinguisher. One isolates, prevents and protects while the other reacts only after a fire has occurred.

Replenishment Buffer =

Safety Stock =

There are four significant differences between replenished and safety stock positions.

1. The Planning and Execution Equation

Replenishment positions are primary in nature. As such, all planning activity flows through this position decoupling discrete demand requirements from generated supply orders. Supply orders are generated based on what zone the "available stock" is in.

DDMRP Available Stock Equation (Finished Items) =

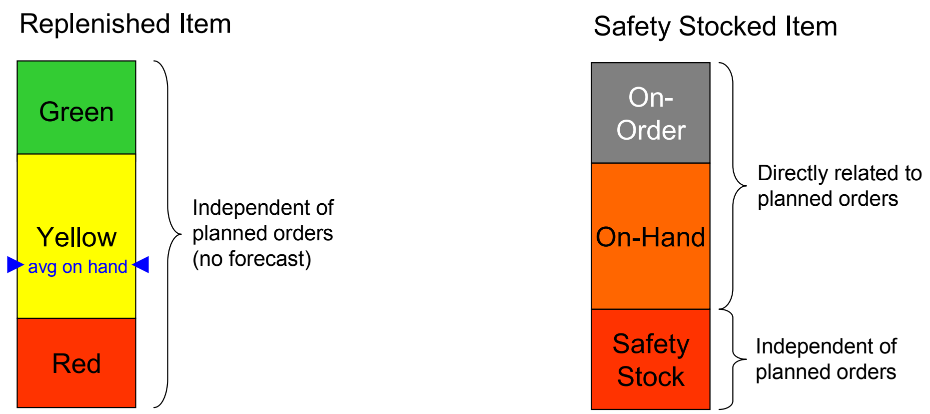
On-hand + On-order (open supply)
– Sales Order Demand (due in the past, due to today and qualified spikes)

DDMRP Available Stock Equation (Intermediates and Purchased) =

On-hand + On-order (open supply)
– Work Order Demand Allocations (due in the past, due to today and qualified spikes)

As seen in the equations above, replenishment buffers use only actual customer demand or consumption (typically represented in the form of Sales Orders). For intermediates, the assumption is that the work order demand allocations are driven by Sales Orders. Replenishment buffers do have a safety zone built into them. Unlike safety stock, however, the penetration of the available stock equation into that safety zone DOES NOT LAUNCH A NEW ORDER, it simply points out the need to consider expediting an ALREADY EXISTING open supply order.

Safety stock supplements supply orders that are generated by a demand allocation explosion; these are typically planned orders that are primarily driven from a forecast. The inventory exposure of a safety stocked position at any one time will be the total of on-hand, on-order and safety stock. The on-hand and on-order sections directly correlate to planned orders. Only the safety stock section is independent of planned orders.



Replenishment positions allow actual demand consumption to be independent of specific supply orders. According to Dr. Eli Berniker, one of the world's foremost experts on Sociotechnical Systems (STS) the DDMRP method has "cracked the problem by, in effect, turning independent demand into what mimics dependent demand via strategic buffers. In place of unreliable statistical forecasts, you have specific requirements calculated within ops for the replenishment of internal buffers."

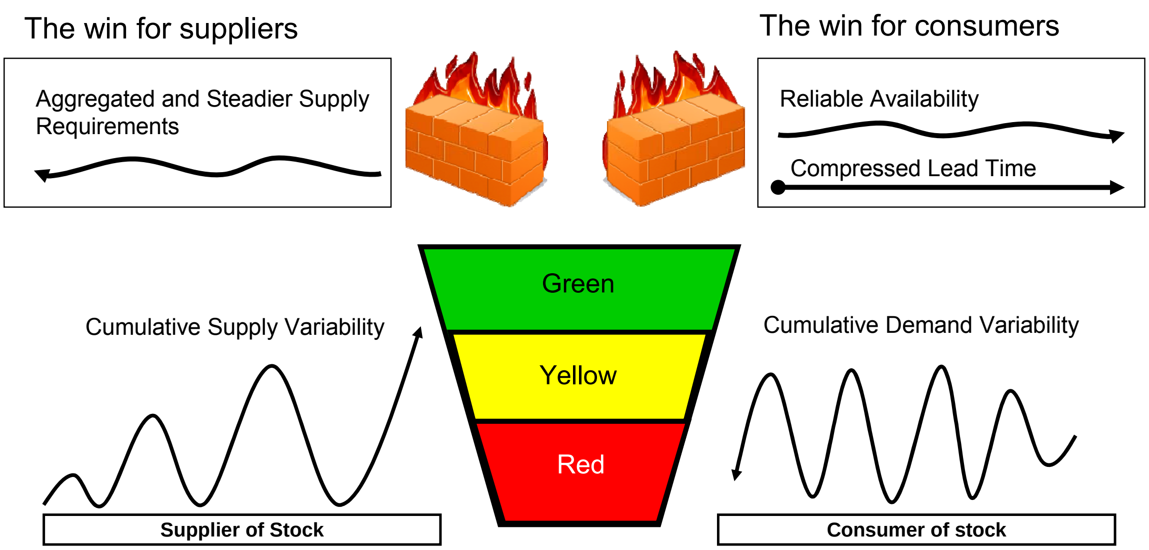
2. Variability Control

Safety stock exists because there will be variation from what was planned versus what is actually needed. Safety stock logic launches AND expedites a new supply order when unexpected variation causes inventory to drop below a pre-determined level. This can act like a grenade thrown over the supplier's fence. This can set off a "bullwhip effect" in most supply chains. The bullwhip effect is defined as:

> *An extreme change in the supply position upstream in a supply chain generated by a small change in demand downstream in the supply chain.* [2]

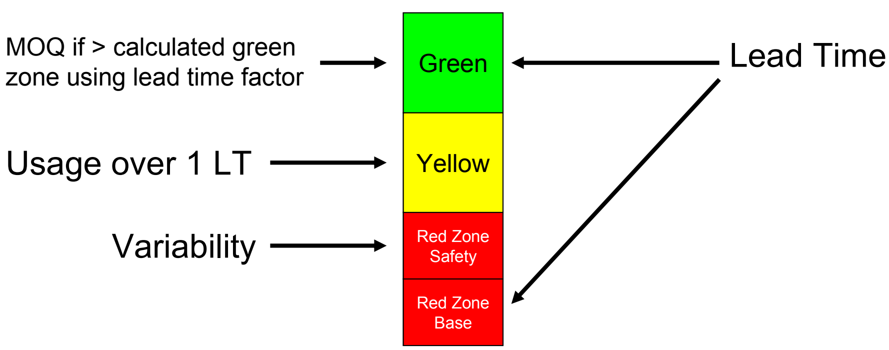
Safety stock can protect only one side of the relationship. This protection can be either inadequate or capital intensive depending on the volatility of demand. Replenishment buffers are designed to protect both sides of the position. On the customer side it allows supplier variability to be dampened thus promoting availability. On the supplier side it allows for a natural aggregation of real demand and consumption. This naturally dampens variability from the demand side AND allows for batch performance that relates to actual demand.

[2] APICS dictionary 12th Edition Blackstone 2010



Replenished positions are not susceptible to the forecast error or the order spikes that typically overwhelm or grossly inflate statistical safety stock positions. This is because, with regard to replenished positions, only sales orders are considered. Forecasted orders are simply not part of the supply generation equation. You cannot be susceptible to the error of something that is irrelevant.

Additionally, replenished positions have two forms of spike protection. Replenishment buffers do have a safety zone built into them. One of the critical elements in sizing that zone is the buffer profile that the replenished item falls into (for more information about buffer profiles see Chapter 24 in Orlicky's MRP 3rd edition). Part of the buffer profile determination is the level of variability associated with the parts/SKU that is associated with the profile. A component of that variability is how susceptible the part/SKU is to spikes and magnitude of those spikes.

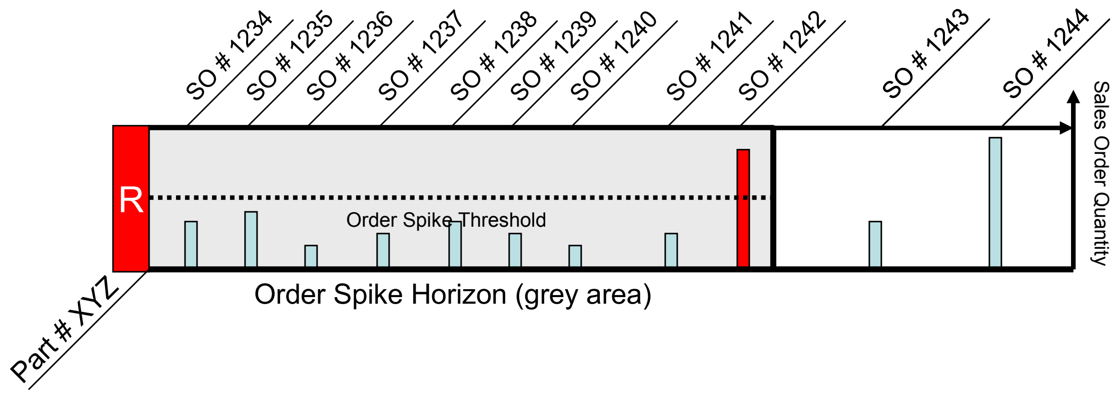


	Green Zone Impact	Red Zone Base Impact
Long Lead Time	20-40% Usage over LT	20-40% Usage over LT
Medium Lead Time	41-60% Usage over LT	41-60% Usage over LT
Short Lead Time	61-100% Usage over LT	61-100% Usage over LT

	Red Zone Safety Impact
High Variability	60-100% Red Zone Base
Medium Variability	41-60% Red Zone Base
Low Variability	20-40% Red Zone Base

This is an example of a strategically replenished position and the factors that comprise the various zones. The zones can be calculated using usage over lead time. The red zone is divided into two tiers – a base and a safety factor. If a part/SKU is in its proper buffer profile then its average on-hand position will be in the lower half of the yellow zone.

The second type of spike protection is much more pro-active and, in many scenarios, allows the amount of safety carried in a buffer to be dramatically lowered. This type of spike protection is called "order spike qualification." Order spikes are Sales Orders that trip an "order spike threshold" within an "order spike horizon."

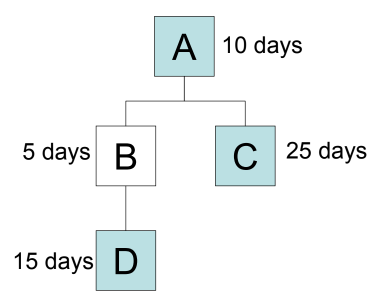


Above you see an example of order spike qualification. The threshold is the dotted line and is set at 50% of the total red zone. The order spike horizon is the shaded area of time representing 10 days. Any Sales Order within a 10 day horizon that is greater than 50% of the total red zone is flagged and put into the available stock equation (Sales Order 1242). Sales Order 1244 is outside of the set horizon so is disregarded in the available stock equation. The order spike horizon should be set at a minimum to the realistic lead time of the part. This can be either the Purchasing Lead Time or ASR Lead Time[3] for manufactured parts.

Order spike qualification is covered in depth in Chapter 25 of Orlicky's MRP 3rd edition. This type of qualification is impossible for conventional safety stock positions. MRP systems do not filter demand for sales orders only within a window of time AND then apply that to a dynamic threshold setting set against a stocked position.

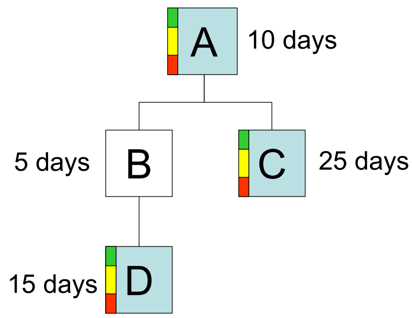
3. Lead Time Compression and Positioning Limitations

One of the most obvious differences between replenished positions and safety stock is their relationship to lead times and where they are placed. First and foremost, replenished positions decouple lead times whereas safety stock does not. Below you see a Bill of Material for parent item A. The shaded boxes represent items that have safety stock and the numbers beside each box represents either the part's manufacturing lead time of purchasing lead time. Note that part B is not safety stocked. Under most conventional approaches intermediate components are not safety stocked since by definition safety stock is intended to guard against the variability of supply or demand. Part B is an internally produced part.



[3] ASR Lead Time is defined as the longest unprotected sequence in the BOM. This is a more realistic lead time. See Chapter 23 of Orlicky's MRP 3rd Edition.

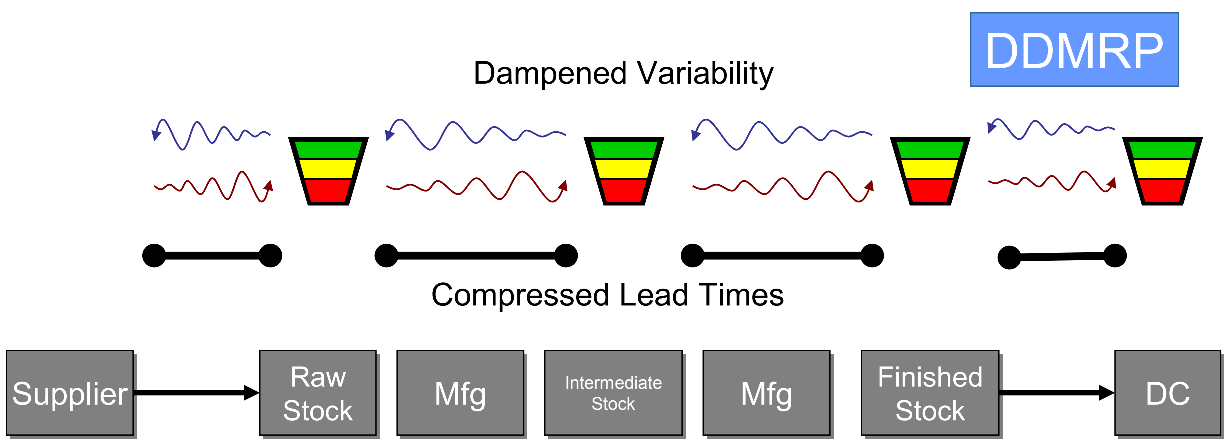
What is the lead time for Part A under these conditions? On one leg of the BOM (A – C) it is 35 days. On the other leg of the BOM (A – B – D) it is 30 days. That means that safety stock for position A will need to account for forecast variability over a 35 day time frame. Additionally, it drives planning to use planned orders at least 35 days in advance in order to create the necessary supply orders. Even in the case where intermediates ARE safety stocked it does not change the lead time equations; 35 days must still be used.

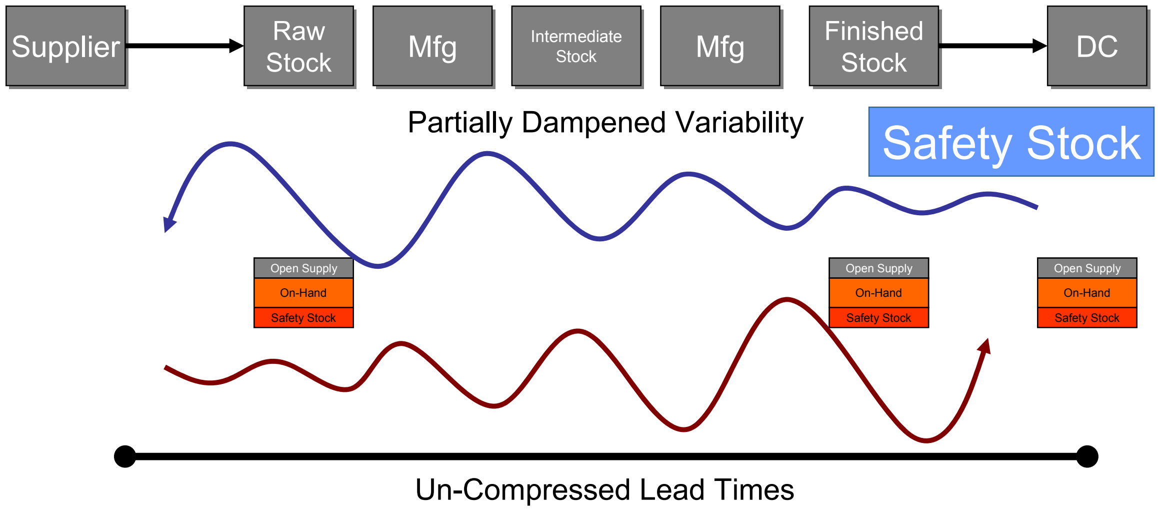


Using a replenished position (symbolized with the three colored bar symbol) the lead time for parent A is decoupled from the supplier lead time since both purchased parts are replenished. Part A's longest unprotected sequence in the BOM is 15 days. This is referred to as ASR Lead Time in DDMRP. The buffer position can now be sized according to Average Daily Usage combined with the ASR Lead Time and under the parameters of the assigned buffer profiles.

Additionally, under DDMRP logic an analysis can easily be done to see if declaring intermediate component B a replenished position is worth the inventory investment. At a minimum it could reduce the ASR Lead Time of Parent item A to 10 days (matching its manufacturing lead time). If intermediate component B is a shared component that feeds multiple parents AND it lies in the ASR Lead Time chain for many of those other parents then it is most certainly worth it. This may seem to be heretical after so many years of trying to flatten BOMs, but, under the DDMRP method companies have actually been inserting layers in their bills in order to take advantage of this common component leverage factor. (Detailed example in Chapter 23 of Orlicky's MRP 3rd Edition)

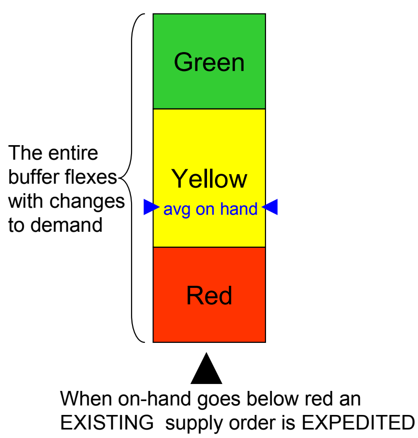
If we look at the above point in a more linear fashion it might look something like the next diagram where, under DDMRP, lead times have compressed and variability is dampened as compared to longer lead time chains with higher degrees of accumulated variability (represented by the wavy lines in both directions).

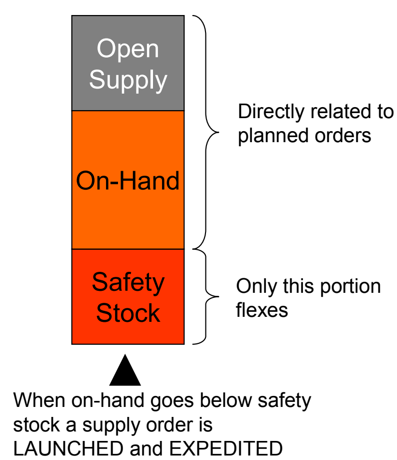




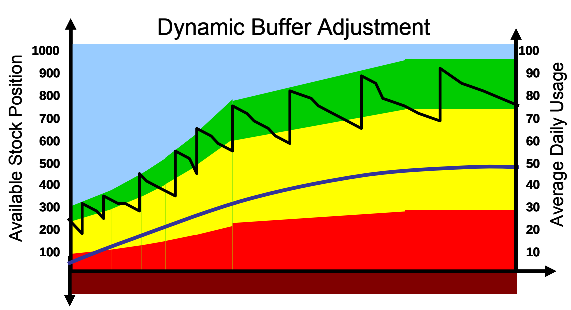
4. *Dynamic Adjustments*

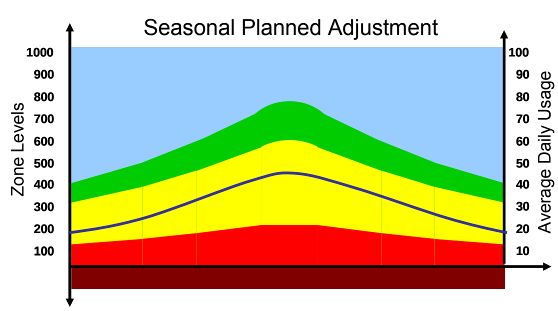
In most cases safety stock is relatively static. There are some very sophisticated dynamic safety stock systems. All of these systems attempt to take forecast variability and combine that with expected changes in demand including promotions and seasonality to adjust the safety stock levels to give better protection within certain windows of time. While this is obviously superior to static positions, the dynamic portion of this approach is limited to the safety stock zone only – the rest of the on-order and on-hand inventory still corresponds directly to planned orders.





With replenished positions the entire buffer flexes with regard to changes in actual consumption or planned adjustments like seasonality, product introduction and/or deletion.





Summary Comparison of Safety Stock and Replenished Positions

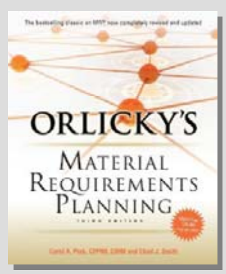
Safety Stock	Replenishment Buffers
A **supplementary** inventory position designed to make up for misalignments between planned orders, actual demand and supply orders	Are **strategic and primary** inventory position designed to decouple areas in order to compress lead times and dampen variability
Planned orders pass OVER safety stock positions. Safety Stock is a reaction point only.	All demand (actual + qualified spikes) is fulfilled from the buffers – they are planning and execution points.
In most cases they are static buffers	Dynamically adjusted
Do not impact lead times	Directly compress lead times
Are not placed at intermediate positions	Are often placed at intermediate positions
Any encroachment triggers a **new** supply order that is flagged for expedite	Encroachment into red zone triggers an expedite of an existing open supply order
Protects only one side of the stock position	Protects both side of the stock position

The third edition of *Orlicky's Material Requirements Planning* tells the story of MRP; its past, its present and the blueprint for its future. The future, something called Demand Driven MRP (DDMRP), is a true multi-echelon supply chain solution that represents a fusion of the still relevant aspects of MRP and DRP combined with the pull-based methods of Lean and the Theory of Constraints and incorporates revolutionary innovations. The future is now.

Official book page at:
www.orlickysmrp.com

Praise for the new Orlicky's Material Requirements Planning (Ptak and Smith, McGraw-Hill, 2011)

"**It is in short the best book in this subject area that I have ever seen.**" John G. Schleier Jr.



"This is a very useful and brilliant book. Ptak and Smith have resolved the core problems of MRP systems." Eli Berniker PhD

"This comprehensive text will, in my opinion, become THE new standard for anyone who wants to get ahead in manufacturing." William M Hewitt

"Carol and Chad: as one of the original MRPers, I applaud you and thank you for your work, and for advancing, with this book, our science more than any other has done in many years." Bob Reary

About the authors

To learn more about Demand Driven Material Requirements Planning go to www.demanddrivenmrp.com and explore whitepapers, downloads, podcasts and special book offers.

Carol Ptak is currently a partner with the Demand Driven Institute, and was most recently at Pacific Lutheran University as Visiting Professor and Distinguished Executive in Residence. Previously, she was vice president and global industry executive for manufacturing and distribution industries at PeopleSoft where she developed the concept of demand driven manufacturing (DDM). Ms. Ptak is also a past president of APICS and has authored several books on MRP, ERP, Lean and Theory of Constraints (TOC).

Chad Smith is currently a partner with the Demand Driven Institute as well as cofounder and managing partner of Constraints Management Group, a services and technology company specializing in pull-based manufacturing, materials, and project management systems for mid-range and large manufacturers. He has been at the forefront of developing and articulating Demand Driven MRP (DDMRP) and is also an internationally recognized expert on the Theory of Constraints (TOC).

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