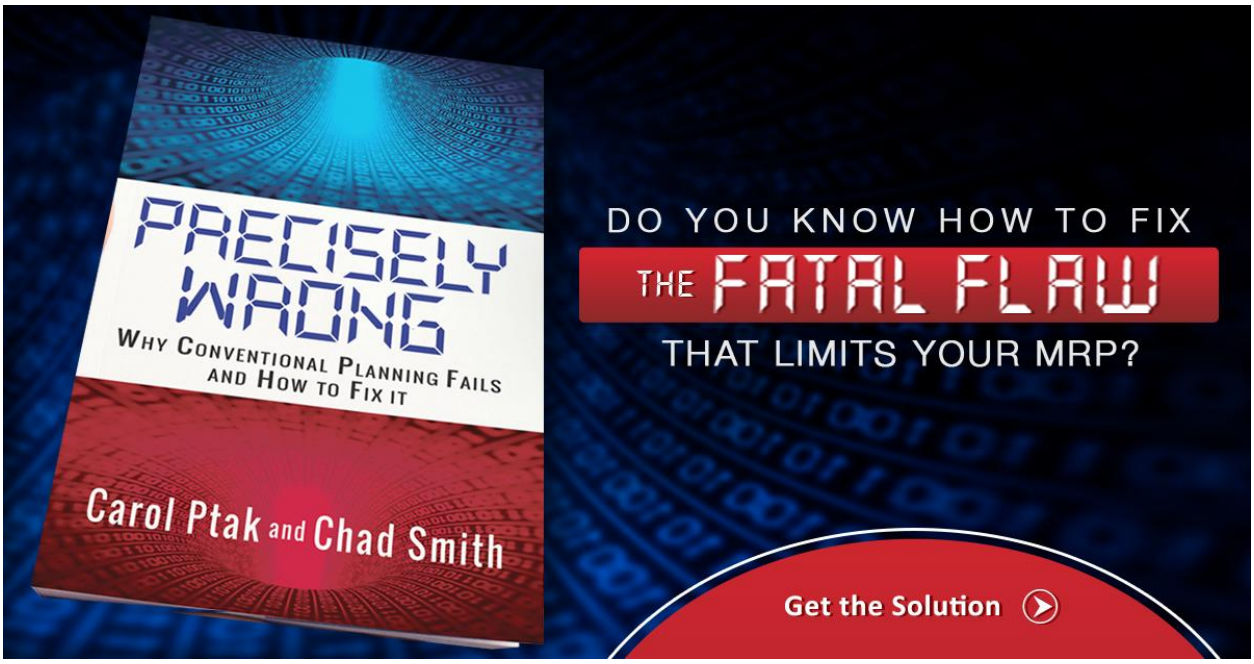
The Story Behind DDMRP

Appendix E from

Precisely Wrong – Why Conventional Planning Systems Fail and How to Fix It



Demand Driven™ INSTITUTE

www.demanddriveninstitute.com

With affiliates, compliant software alliances and instructors throughout the world we are changing the way businesses plan, operate, think and evolve. Every business has a choice; continue to operate with rules, metrics and tools developed more than fifty years ago or make a break from convention, recognize the complex supply chains we live in and make a fundamental change in the way it does business. We are the leading authority on the development and application of demand driven principles.

For more information about our mission and how you might get involved, please contact us at: info@demanddriveninstitute.com

The Story Behind DDMRP

By Chad Smith

While much has been written about Demand Driven Material Requirements Planning since its release to the public in Orlicky's Material Requirements Planning 3rd edition in 2011, very little has been written about the story and team behind it. In this Appendix I will attempt to chronicle the experiences and environments, to the best of my recollection, which led to the body of knowledge that we see today in DDMRP.

Introduction

The last thing in the world I ever expected to be a part of was something with "MRP" in the name of it. When Carol and I decided on "Demand Driven MRP" we looked each other in the eye and said, "Do we really want to do that?" The answer was, "well, that is what it is." We recognized that probably the last thing the world needed was "another version of MRP". MRP was old, not sexy and had no sizzle in any way, shape or form. But, we felt it was important to be true to what we were actually doing. We got the blessing from people like Gene Thomas (who worked hand in hand with Orlicky). I personally went to Chicago to meet with him. He even wrote the appendix for the third edition of the Orlicky book.

So why has DDMRP made the noise it has? Is it clever marketing? We have no marketing executives. DDI's marketing spend for 2017 will be under $1,000. Our social media presence and growth is completely organic. Is it a rebrand? That is a very fair question. Carol and I from the very beginning have made it clear that we were building from foundations based in MRP, Lean, TOC and Six Sigma. We took the work of a very smart team of people and articulated a couple of innovations that allowed us to define a step by step blue print that almost any planner with a moderate amount of experience could follow and get results with. They started doing just that. Then things started getting interesting. Companies began to implement the concepts at a larger scale and bottom line results followed.

In this war of acronyms and "better ways" I believe there are only a few things that matter. Logical clear explanations that resonate with people (executives AND users), results that people can relate to and TRANSPARENCY in the solution. When planners understand the what and the why of the system recommendations, AND those things actually make sense, they get very excited. Black boxes with advanced algorithms (many of which are based on the wrong rules) will most likely not meet that criteria. Too many of these acronyms are thinly veiled software plays anyway. **DDMRP was built for people not perfection.**

Thus, our number one objective was to be transparent. This is extremely important in people trying, testing and also being consistent across industries. In just five years we have put thousands of people through our educational programs, and have hundreds of companies (some very large MNCs) extensively implementing the concepts. We also have many DDMRP compliant software systems that are consistent across the board in how they perform the DDMRP equations. We also have the large ERP companies raising the DDMRP flag. We have more on the way that we hope will cover about 50% of the world's mid and upper range ERP market by the end of 2018. Stop by our site and see why we are so excited: https://www.demanddriveninstitute.com/

Oregon Freeze Dry: The Light Bulb Moment

In 1996, I was working as a Regional Director for North America for the Avraham Y. Goldratt Institute. I had a territory that covered the northwest of the United States and Western Canada. I was contacted by Larry Von Deylen, VP of Marketing at Oregon Freeze Dry. He was intrigued about the potential applicability of applying the Theory of Constraints to their business.

It was unusual to be contacted by a marketing person to say the least. But Larry was focused on service (not unit cost) and was looking for a way to better support their market position. We talked about the idea of replenishment and running more to market pace rather than forecast. He thought the idea had merit and took it to the VP of Manufacturing. The message was not received very well.

Larry was so persistent internally that the two Vice Presidents agreed to switch positions. Larry now had the authority to try this out. Very simple buffer designs were constructed. Across the board minimum run sizes were challenged. The solution was implemented relatively quickly and with a minimal amount of consulting services or technology. A few months later the results spoke for themselves and Larry shared them at an annual conference.

<u>Division A: Mountain House Brand Products</u>

- Sales: Up over 20%
- Shipping: July – October 1997 (prior to solution) 1164 shipments, 245 shipped late
  July – October 1998 (after solution) 1697 shipments, 11 late
- Inventory: 60% less inventory on hand

<u>Division B: Industrial Ingredient Business</u>

- Lead Time: 10-12 week lead time reduced to 3 weeks!
- 60% reduction in make- to order lead time!
- Shipping: Improved from 97% to 100% on time delivery
- Inventory: Reduced by 21%

Since the beginning of their journey in 1998 they experienced a 13X growth in sales and only a 2X growth in inventory with no major capital additions and all the while maintaining a 98+% on time delivery.

It should be noted that these results were not attributable to any brilliance on my part; I played a very minor conceptual role. It was Larry's leadership and a bright young assistant Craig Jolly that brought them to fruition. These results were a game changer for me as well. They convinced me that there was tremendous power and leverage from a concept that was relatively simple and straight forward yet did not seem to be apparent to industry.

It also began to highlight to me as a consultant focused on the Theory of Constraints what we were missing. One of those things was a true understanding of the impact of MRP on resources and schedules. MRP was treated as a given. We were focused on scheduling and execution capability. The TOC community in general was in love with the concept of Drum-Buffer-Rope (DBR) but did not really understand what was happening at the planning level that created the order signals in the first place. This was never obvious in the job shops where DBR first flourished but in the larger manufacturing

entities it became readily apparent. I was actually part of DBR implementations in which we simply helped companies make the wrong things faster and there was a constant dogfight about the schedule.

The Charles Machine Works: The Power of Decoupling

By 1997 I had left the Goldratt Institute and co-founded a company called Constraints Management Group with Debra Smith. We expanded that partnership in 1998 to include others; Greg Cass, Michael Pitcher and Jeff Herman. Our first large, complex account as a new partnership was a company called The Charles Machine Works (better known by their brand name as Ditch Witch). My partner Debra Smith was initially contacted by their accounting function. They were much intrigued by the message they heard at a conference regarding the dangers of cost accounting and the need to return to driving operations based on managerial accounting concepts.

Ditch Witch, headquartered in Perry, Oklahoma is well known for trenching and directional boring products. Their factory encompassed over one million square feet under roof staffed by 1,800 people with a vertically integrated supply chain that included its own electronics manufacturing. Their products are complex in nature. End items have 8-10+ layer product structures, multiple configurations and large service parts demand from an international network of dealers.

The plant was essentially divided into two parts. Machining and fabrication made the thousands of components required and eleven assembly lines assembled those components into end items. Separating these two sections of the plant was a place called the manufacturing warehouse. It was essentially a staging queue for all the components flowing from the machining and fabrication side to the assembly side. It was all work in process inventory and where they sent their entry level people to work.

This is where we decided to first attack. Many of these items were shared components (hydraulic cylinders, frames, buckets, blades, etc.). Regardless of what end item the component supported, they all used common machining and fabrication capacity. Tightly synchronizing the schedule from end item all the way through the product structure was wreaking havoc. Very few orders were ever released with full allocation and assembly line supervisors hoarded scarce parts to keep their own lines running. Midnight raids for scarce components was commonly joked about but only because it actually took place on a regular basis. There was no way to gain control of this plant and harness the power of a better resource scheduling solution (Drum-Buffer-Rope) unless we could guarantee material availability to the assembly lines. Without that guaranteed material availability we had no hope of scheduling the assembly lines to a finished goods demand signal.

We stopped the explosions of end items at the intermediate component levels and built true stock buffers at the manufacturing warehouse level. They moved some of their best people to the stores area to maintain control and allocate components to each line based on actual orders. Their green screen legacy planning system was custom coded to support this functionality. Ditch Witch IT worked hand in hand with our partner Greg Cass to determine the specifications and functionality required to implement and maintain this decoupling inventory.

This decoupling inventory combined with drum scheduling for constrained resources on both side of the inventory yielded results that were nothing short of staggering. Lead times dropped from 90 days to 14 days with an inventory reduction of around $35 million. This showed us that decoupling within the

product structure had enormous value. Additionally, it showed us that in larger, complex manufacturing entities the combination of decoupling point inventory with finitely scheduled drums was a formidable combination. This was the beginning of the development of the Demand Driven Operating Model. It also became apparent that the ability to do this at large scale would require fundamental changes to planning systems.

Jamestown Container Companies: Bringing the Solution to the Customer

In 1999 my partner Michael Pitcher called me and said that he would like me to meet with a client in New York. They were a regional packaging company with plants in New York and Ohio. They owned a part of a paper mill and even had their own corrugator. We had extensive meetings with the son of the majority owner, Bruce Janowsky and his team.

The Jamestown Container Companies competes in an industry mired in overcapacity, high fixed costs, intense price competition and spiraling margin erosion. Jamestown Container was looking for a solution that would create a unique value for their customers through shorter lead times and higher customer service levels. Unparalleled speed, quality and service were core to their strategy.

An offer was constructed to major customers that would position buffers of packaging stock at the customer site. Electronic consumption signals would be conveyed daily and buffers would be replenished as necessary from Jamestown's local factories. This would minimize the amount of inventory at the customer site but allows for inventory to always be available. Additionally, price would be determined not based on a single purchase but based on annual volume. In this regard, the customer is not put in a dilemma about making large buys that may be above their current requirements and the Jamestown supply chain does not have to absorb large pulses of work.

The Results:

- Operating Profit up 300%
- Inventory down 40%
- Lead times down 70%
- Expedites nearly eliminated
- Inventory turns from 10 to 42

Roseburg Forest Products: The Power of Vertical Integration and Shared Materials

In 2002, the CMG team was introduced to Roseburg Forest Products (RFP). RFP, located in Oregon, was one of the largest closely held wood products companies in North America with over $1B in sales. They were a major player in the North American plywood market having the largest softwood plywood mill in the world. They manufactured dimensional lumber, particle board and engineered wood products (EWP) and were the largest supplier of plywood west of the Mississippi. Additionally, they had the largest privately-owned timberlands in the United States, with forest lands in Oregon and Northern California.

Across their product spectrum there were literally thousands of different product SKUs. They sold to major chains such as Home Depot that required mixed railcar loads of product to supply their different regional warehouses. These mixed loads would include a wide and constantly changing variety of items.

These mixed loads would have to be fulfilled by a number of different facilities requiring major coordination and significant delays (1-2 weeks).

At the base of all this complexity was extreme simplicity. All products came from just a few varieties of logs. There were three choices for a log; sell the whole log, send it to the dimensional lumber facility or send it to the plywood facility. Introducing a log into a manufacturing facility requires it to be processed in one of two ways; either peeled (for plywood) or cut for dimensional lumber. Either way the particle board plant got the byproduct of each facility in the form of chips. Once that initial decision was made, the number of available options to utilize the log reduces dramatically at each stage of production. Each profit center, Forestry, Plywood and Lumber were all competing to utilize the best logs.

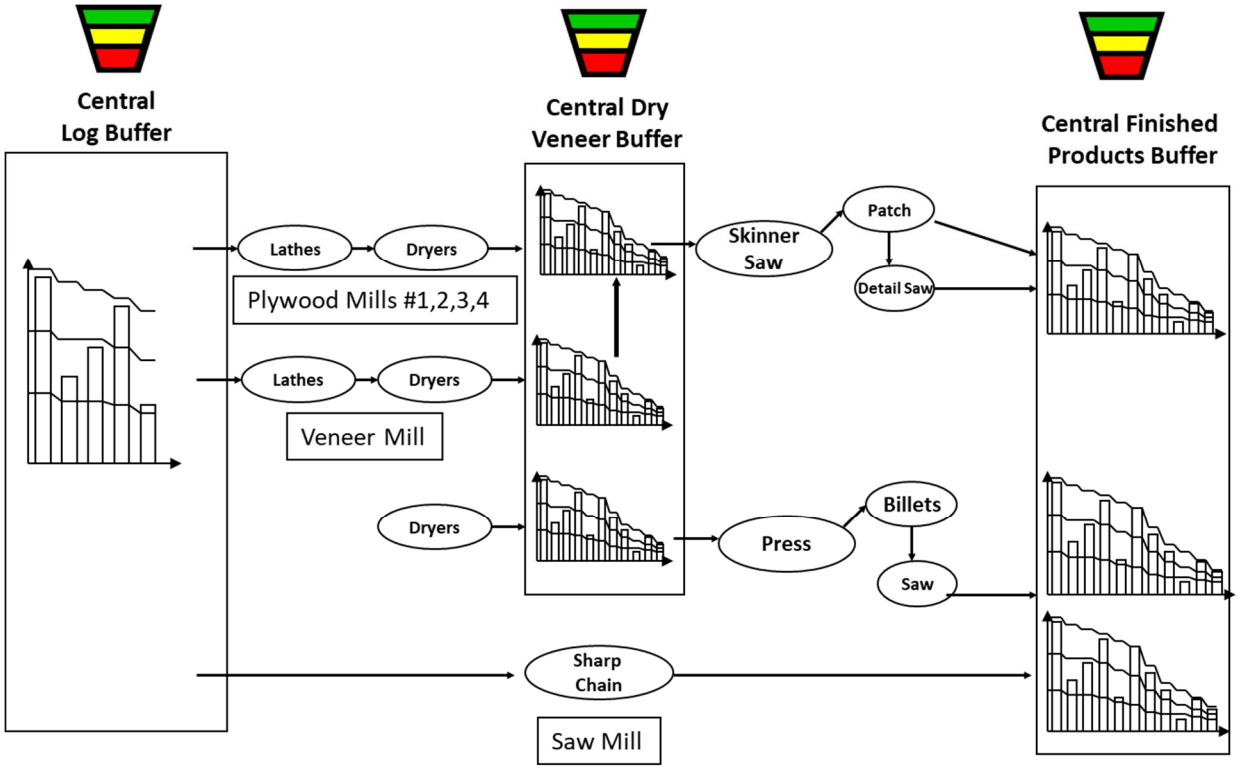
If logs are "pushed" through the system then inevitably they ended up with the effect of too little of the right option and too much of the wrong even though they had enough logs to start with. This required supplementary logs to be purchased as well as excess veneer from the peeled logs to be sold off at a huge discount before it rotted.

A supply chain design was constructed that provided the ability for:

1. Mixed car shipments to be fulfilled within 1-2 days of being ordered. This was accomplished through a finished wood products buffer comprised of the majority of items typically sold for mixed car shipments. This allowed for quick service to the customer as well the protection of manufacturing assets from schedule break-ins and expedite orders.
2. Logs were introduced and used only as required. This was accomplished through a central log buffer. This central log buffer allowed for instant availability of specific specie logs to the manufacturing assets and required that the logs be pre-sorted and stored in the log yard by attribute. Additionally, it clearly pointed out when surplus logs could be effectively sold off and when shortages required logs of specific species to be held back, logged or purchased.

Figure E-1 is the Roseburg Forest Products supply chain design. As can be expected, the results were dramatic. Service levels rose dramatically (from mid 40% to mid 90%),inventory reduced dramatically (in excess of $50 million), volume increased 20% with one less plant and 450 less employees and lead times went from 14 days to 2 days. ROCE numbers went from 0.5% to 19%!

Figure E-1: The Roseburg Supply Chain Design



Roseburg was an important client for CMG. We were beginning to put it all together regarding strategic buffering at all levels of the product structure and in different scenarios. It also convinced us that complementary software would be required to effectively implement and sustain these efforts in larger entities with mainline ERP products.

LeTourneau Technologies, Inc. (LTI): Modern Buffer Design, Decoupled lead time and the matrix BOM analysis

Dubbed the "mighty movers of the earth", The LeTourneau Technologies, Inc.™ (LTI) companies included some of the world's leading innovators in manufacturing, design, and implementation of systems and equipment for mining, oil and gas drilling, offshore, power control and distribution, and forestry. Most of their products shared three main traits; they were extremely complex, high-load bearing and comprised of a lot of steel. Some of their end items had over 100,000 parts with product structures as deep as 27 layers!

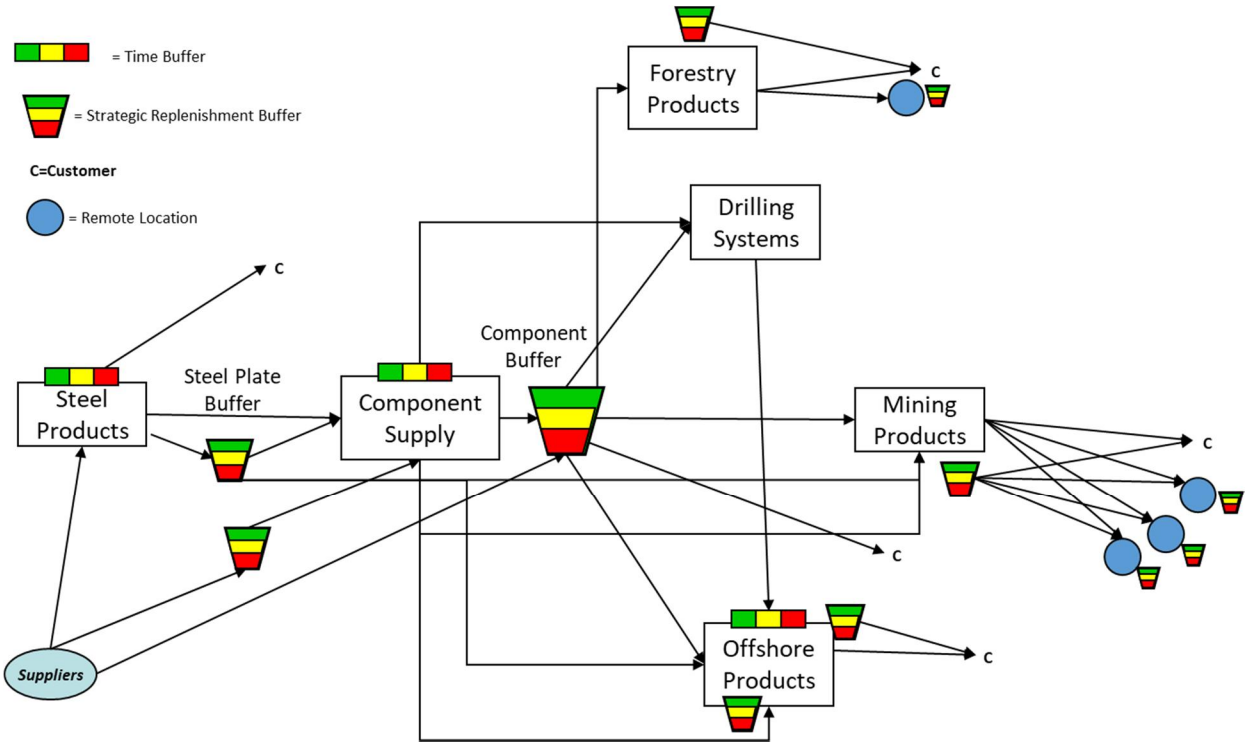
We were introduced to LTI when they mistakenly attended our annual conference thinking it was an APICS CMSIG conference. Rudy Harris, head of Company Improvement Work (CIW) and right-hand man to CEO Dan Eckermann, led the LTI group at the conference. They heard Roseburg Forest Products speak about their success and made a critical connection. They talked to Jamestown Container as well as many other companies that were implementing these methods. My partner, Debra Smith led the charge in getting a session with their entire executive team to redesign their supply chain at their Longview facility.

Figure E-2 depicts the new LTI supply chain design with both strategic stock buffers as well as control points designated. This design features tiers of buffers that resulted in dramatic lead time compression, much higher service level performance, and inventory leverage.

Before this design, MRP would calculate requirements from end item demand all the way through to the rolling of the necessary plate in the mill. Material shortages caused cascading disruptions throughout the company. Overtime and expediting was the standard mode of operation. Since everything is steel intensive, a steel plate buffer was inserted between the steel mill (Steel Products) and Component Supply. This took the pressure off the mill to synchronize scheduling activity with Component Supply. That made outside steel sales easier to take and schedule.

A component buffer was placed between Component Supply and the various business groups (Mining, Offshore, Forestry, Drilling) allowing them to assemble on demand independent of Component Supply schedules. Service parts buffers allowed each business group to service their markets without expediting requirements through Component Supply. Some business groups had dealers in remote locations with their own service parts buffers. Finally, it should be mentioned that control point scheduling with time buffers was occurring in the Steel, Component and Offshore groups.

Figure E-2: LTI supply chain design



It should be noted that this schematic is an oversimplification for many of the products. The product structures were both broad and deep. It was necessary to pinpoint which specific components within and across product structures really mattered. This led to the discovery and articulation of the longest unbuffered leg or coupled sequence. This would lead to the concept of decoupled lead times. By importing the product structure with fixed lead time into a project management tool, these longest chains became visible. The placement of each additional decoupling point exposed where the next

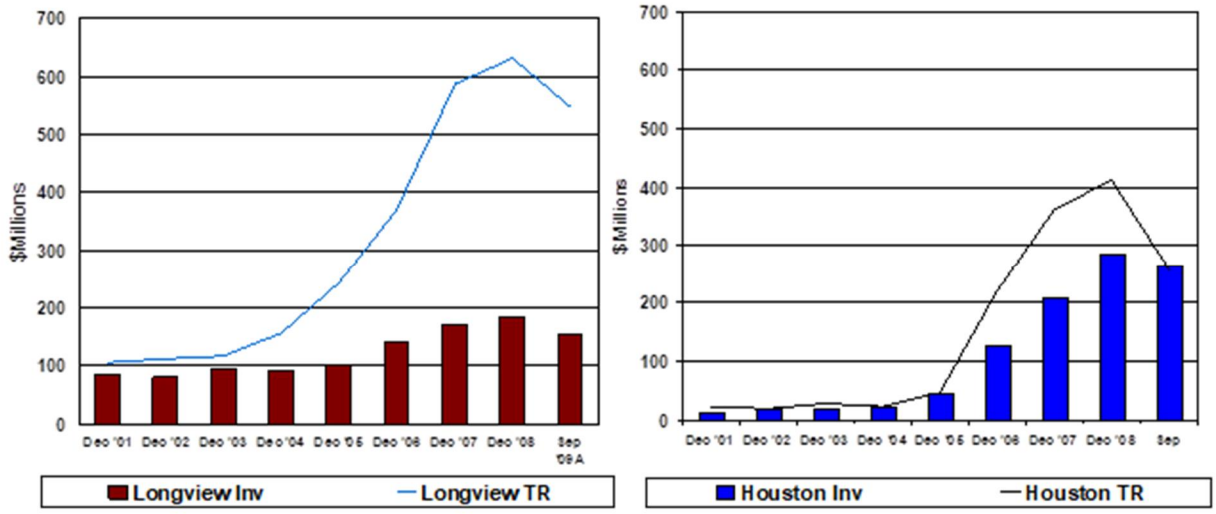
longest chain would occur. This brought tremendous insight for three reasons. First, it allowed for dramatic lead time compression without putting inventory everywhere. Second, it allowed for the proper sizing of buffers. Third, it clearly showed a point of diminishing returns to the placement of decoupling points resulting in the actual removal of some stock buffers.

The modern DDMRP buffer designs (see Chapter 5) were birthed at LTI. It became apparent that a one-size fits all strategy would not work. We could not simply use a one-third green, one-third yellow and one third red design. Items were different when it came to lead times, variability and which group controlled them. We knew that many components behaved differently but at the same time many (even if they were unrelated) behaved similarly. This brought about the idea of buffer profiles; groups of parts that had similar traits. It also forced us to understand the real purpose of each zone of the buffer and create appropriate rules based on that purpose. We knew that lead time and variability were important to sizing buffers but they each impacted the sizing in different ways. For example, parts that were more variable need bigger red zones and parts with long lead times needed smaller green zones

One person that needs to be mentioned with regards to these developments is Greg Cass. He led the way in developing these approaches and the software capability/specifications to accomplish them. Those specifications created the first DDMRP software package called Replenishment+. My job was primarily how to articulate this new method as the insights became clear.

In the third edition of Orlicky's Material Requirements Planning we shared the LTI results. LTI had two main manufacturing facilities (Longview, TX and Houston, TX) that are similar in terms of capability, product complexity and size. The performance reports in Figure E-3 demonstrate dramatic differences in performance between the two comparable campuses of Longview and Houston. The type of manufacturing is very similar both in terms of complexity and scale. The difference was how each was managed. Longview used DDMRP tactics while Houston used traditional MRP tactics.

Figure E-3: Longview versus Houston



Beginning in 2005, the market began to rapidly expand for all LTI business segments. This boom-bust cycle was not a new phenomenon for LTI. Typically, LTI's inventory and expenses would rise at a similar rate as revenue; service levels deteriorated at a proportional rate. However, in the 2005 boom, the Longview facility embraced the new business rules of DDMRP in conjunction with their partial implementation of DBR. This facility could dramatically control inventory and expenses while maintaining excellent service levels. This is noted in the graph on the left in Figure E-3.

All boom markets eventually end. In this case, the markets began to cool off in 2008. 2009 brought a significant decline in revenue. When the boom times were over, DDMRP at Longview minimized the company's exposure to inventory liabilities. No matter what kind of economic times a company finds itself in, good inventory and capacity practices that minimize inventory exposure while maintaining service levels provides sustainable financial success for the company.

Figure E-3 shows Total Revenue (TR) versus Inventory from 2001-2009 from both the Longview and Houston sites. Note, beginning in 2005 there was dramatic growth at both sites. In Longview, revenue grew by a factor of greater than 300% (over $400 Million). Over that same period, inventory rose only by 80% (about $80 Million). In Houston's case, however, inventory ended up growing at nearly the same rate as revenue. There is about a 6-9 month lag but it is pacing at the same rate. The lag was due to their policy to build to a forecast. When the future is projected from the past; the boom ends and the future looks nothing like the past; the end result is obvious. It is critical to understand how this impacts ROI. ROI quadrupled at Longview and declined at Houston. Longview added very little capacity while Houston's capital and labor investment grew at the rate of their inventory.

When the market began to turn down at the beginning of 2008, LTI Houston is burdened with significant inventory liability and increased capital investment. Due to the nature of forecasting there is a real risk that the inventory could actually grow beyond revenue in the short run without a massive course correction in the form of PO and MO cancellation and/or delay. Figure E-3 shows that this actually occurred in Houston in 2009. This exposure is a classic effect of traditional planning environments.

Important to note is that the people in the Houston facility were smart, professional manufacturing personnel. They did not have the tools and business rules at their facility to replicate what happened at Longview. The above graph is not an indictment of the people. Rather, it is an effective illustration that the generally accepted rules for planning material represents a huge liability in the volatile and variable manufacturing environments that tend to be today's rule rather than exception.

If you would like to read Dan Eckermann's (CEO of LTI) viewpoint of what happened, he wrote about it in the introduction of the book "Demand Driven Performance – Using Smart Metrics". It is also available for download at www.demanddriveninstitute.com as a paper called "You Can Do This - A CEO's Perspective".

The Meeting: A Problem and Solution Come Together

In 2008, with the blessing and encouragement of my Partners at CMG, I took the Replenishment+ product and some conceptual PowerPoints to Carol Ptak. We both lived in the Seattle area. Carol was the former President and CEO of APICS and was also Vice President and Global Industry Executive for the Manufacturing and Distribution industries at PeopleSoft before the acquisition by Oracle. Carol was then teaching at Pacific Lutheran University as their Distinguished Executive in Residence. She immediately saw that the product and its conceptual framework made possible the vision of demand driven manufacturing that was first developed at PeopleSoft in 2002. This was the missing piece to that strategy. We started writing. She knew the intricacies of the problem and I had been immersed in the solution.

Carol and I wrote a white paper called, "Beyond MRP." On a whim we sent it off to APICS to see if they had any interest in it. The response was almost immediate. APICS asked us to condense the article for their magazine. APICS not only put it in the magazine but made it the cover article under the title "Brilliant Vision" (July/August 2008 edition). Shortly after the article was published, APICS sponsored a webinar in August 2008 with both of us on the subject of the article. Over 200 companies signed up.

With this encouragement, we began to further articulate the solution. We described the solution using the term "Actively Synchronized Replenishment (ASR)". I spoke in November 2008 at the Theory of Constraints International Certification Organization (TOCICO) Conference in Las Vegas, NV. It was there that we were approached by Dr. Jim Cox to continue writing on this topic. Dr. Cox is well known in both the TOC and APICS worlds. He was to be the co-editor with John Schleier of a new book to be published by McGraw-Hill that was to be called "The Theory of Constraints Handbook." Dr. Cox asked us to contribute a chapter to the book. The chapter was submitted about nine months later. Jim and John were very enthusiastic about the chapter content and sent it to McGraw-Hill telling them that there should be a whole book dedicated to this. Below is what John had to say:

> *Wow! What a chapter. My head is spinning around networks of interconnected buffers pulling production from the market side of the supply chain through multi-levels in a shop with other buffers protecting its supply side. This is really an exciting story about a very creative piece of work. I wrote the first MRP system for John Deere's Ottumwa, Iowa plant in the late 1950's; automated the BoM's, Routings, Inventory Records, MRP, Shop Floor Scheduling, and the Purchasing System. Then in the early 60s I then headed the development team that built the compliment of logistics systems for the IBM Rochester Plant, later implemented at the IBM plants in Boulder and Boca Raton, with* elements in IBM European plants. *I only mention this to*

frame my appreciation for the incredible progress reflected in your work on ASR. Congratulations! I wish we had some of these solutions back then…. I am really blown away by the caliber and scope of this work. John Schleier

In the spring of 2010, McGraw-Hill offered Carol and me a contract to write the third edition of Orlicky's Material Requirements Planning. We immediately realized how important and significant this solution was. We could now bring DDMRP directly into the mainstream. In May 2011, Orlicky's Material Requirements Planning 3/E was published. While writing this book "Actively Synchronized Replenishment" was changed to "Demand Driven Material Requirements Planning" to acknowledge the significance of MRP in the solution and for the future. The book featured six chapters on the method and represented our best understanding at the time. We founded the Demand Driven Institute and developed courseware – the Demand Driven Planner (DDP)™ Program. But more development and articulation was to come.

Unilever: Prioritized share, the hybrid, planned adjustments and the birth of DDS&OP

In the spring of 2009 I received a call from Carmine Mainiero. He worked for Unilever. He said that he was at a conference and saw Carol Ptak speak about the problems of conventional planning and a new method being developed to correct it. She had told him that he needed to talk to the people at CMG if he was serious about learning more. He told me that what intrigued him is that we actually had answers and details about how to do it rather than the vague conceptual responses he was getting from the analyst firms talking about "demand driven". A year and a half later (yes, that long) I traveled to Englewood Cliffs, New Jersey to give Carmine and his boss a briefing about this method.

It was well received and we began looking for landing spots for a pilot. We found that landing spot in a plant in Bramalea, Ontario. Unilever brought with it challenges that we had not seen before. The first being a massive amount of promotional activity (much of which was not well communicated in advance). This led to an emphasis on better developing planned adjustments and simulating their impact with on inventory, space, capacity and long lead time materials. Implementations in additional plants in North America brought new challenges. We learned that distribution space across the network had to be carefully utilized due to space limitations and capacity challenges. This led to understanding how to properly balance inventory across the network. These situations directly resulted in the hybrid model and the prioritized share schema (both of which are described in Demand Driven Material Requirements Planning).

In June of 2016, Demand Driven Material Requirements Planning was published. The book dramatically expanded the DDMRP body of knowledge and included these latest developments. While there are still lessons to learn and areas to develop, the DDMRP body of knowledge is now relatively large and robust. This engine is being implemented consistently across the world in a variety of industries. While Carol and I have been at the forefront of articulating DDMRP, the invention of the method took a team of thought leaders with complementary skill sets nearly 15 years. It also took some amazing and courageous people who believed in doing the right thing for their company to make it happen.

Summary

One extremely fulfilling thing to see is that development on DDMRP continues. New knowledge has been created with regard to applying DDMRP to retail and discontinuous demand. PhD level research on DDMRP is beginning to take off. Experiential simulations have been developed. The best part of all of this? Carol and I had little to no part of it. DDMRP is bigger than Carol and me. It always has been and it always will be.

About the Author

Chad Smith is the co-author of the third edition of Orlicky's Material Requirements Planning 3/E (Ptak and Smith, McGraw-Hill, 2011), Demand Driven Performance – Using Smart Metrics (Smith and Smith, McGraw-Hill, 2013) and Demand Driven Material Requirements Planning (Ptak and Smith, Industrial Press, 2016). He is a co-founder and Partner in the Demand Driven Institute, an organization dedicated to proliferating demand driven methods throughout the world. Chad served as the Program Director of the International Supply Chain Education Alliance's Certified Demand Driven Planner (CDDP) Program from 2012 to 2016.

In 1997 Chad co-founded Constraints Management Group (CMG), a services and technology company specializing in demand driven manufacturing, materials and project management systems for mid-range and large manufacturers. He served as Managing Partner of CMG from 1998 to 2015. Clients, past and present, include Unilever, LeTourneau Technologies, Boeing, Intel, Erickson Air-Crane, Siemens, IBM, The Charles Machine Works (Ditch Witch) and Oregon Freeze Dry. Chad is also a certified expert in all disciplines of the Theory of Constraints studying directly under the tutelage of the late Dr. Eli Goldratt.

Chad makes his home in Wenatchee, WA with his wife Sarah and two daughters Sophia and Lily.

LinkedIn Page: https://www.linkedin.com/in/demanddrivenchad
Follow Chad Smith on Twitter: @demanddrivenmrp
Amazon Author Page: http://www.amazon.com/Chad-Smith/e/B005D4X8AM/