Practical Application of the Lean/Operational Excellence Transformation Process

Bill Foughty

My experience in the application of lean methodologies has been developed over a number of years and is a combination of real world hands-on application as well as classroom training and reading. I have led or participated in a lean transformation process for 3 major companies and started practicing lean at a time when it was not as understood or in widespread use as it is today.

Black & Decker

For the most part, a lean transformation results from the application of common sense tools and processes to any type of operation (be it manufacturing shop floor or the front office). In 1996 I was asked to develop a plan to streamline and improve our lockset make-to-order business in Anaheim, Ca. I pulled together a core team – a long tenured process engineer, a long tenured "keying" expert, a data analyst/systems expert, and a recent college engineering graduate that was intended to be our person to challenge our "business as usual" mindset. Our goals were simple – reduce lead times (from 4+ weeks to 1 week), reduce inventory levels, improve efficiencies, and improve quality.

Our concept centered around the development of a manufacturing flow process, a simpler method of forecasting, and building a system that was able to operate independently of product mix (ie, demand was strictly a consumption of total capacity and not consumption of dedicated manufacturing line capacity). The existing operation consisted of multiple dedicated manufacturing lines (door knob, lever set, handleset, deadbolt) with direct labor that was somewhat inflexible and assigned to a specific manufacturing line. In addition, from a forecasting perspective, our process focused solely on the end product SKU's that our customers (new home construction builders) would order – a nearly impossible task due the extremely large configurable end product options – with the resulting raw and in-process inventory levels being excessive. With our goals and concept set, we were tasked with developing the new system.

Process

Our first step was to perform a very thorough analysis of data related to our products. We analyzed what products should be grouped together, the sub-assembly building blocks (those that could be quickly assembled to produce a final product), which raw

materials could be modified and made common across a larger base, and so forth. What we found was that through minor engineering changes we could eliminate a large number of raw materials (packaging for example) which would allow us to reduce the total value of raw materials needed.
We also found, based on allowable configurations, that we could support almost any (>95%) end product SKU's by stocking about 1200 sub-assemblies and through analysis of historical consumption of these sub-assemblies make some sound statistical guesses on the correct WIP inventory levels and replenishment order points. In addition, we spent considerable time analyzing ways to reduce quality defects typically produced during the build/assembly process, determining how new systems could best support streamlining efforts, the overall layout and concept of how to create flexible capacity that was mix independent, and how we could improve our overall supply chain.

After many refinements our end concept was accepted. After considerable debate, however, the new methods were determined to be so revolutionary that we would face extreme difficulty implementing the changes in the existing culture and facility in Anaheim, Ca. As a result, it was decided we would build a new plant and physically attach the facility to the Black & Decker North American distribution center in Charlotte, NC.

Concept

Our final concept was actually quite simple - create a closed loop conveyor system where case pack quantities of customer orders were released at a starting point in plastic containers. These bar coded containers would move through the conveyor system and be electronically diverted to the appropriate inventory storage locations where operators would collect the necessary sub-assemblies through application of pick-to-light technology. The containers would then move through initial operations (such as setting the keying sequence) then finally end at a universal assemble and pack to order work station. The final packed cases, with their appropriate customer order information bar coded onto the container, would be diverted to pallet build locations and prepped for "shipment" to our distribution center.

Systems

Several new systems were developed to support the new plant. We developed a sophisticated *Advanced Planning & Scheduling* system that helped determine the timing of release of orders based on well defined criteria such as customer ship date, inventory levels, combination of like orders, etc. This system was combined with our standard ERP system and from a material planning standpoint we now used MRP primarily as a long term forecasting tool versus the traditional short term material requirements planning function. In addition, we developed pick-to-light applications for our inventory locations. This system was used to indicate to our sub-assembly pickers, after a container entered an inventory location, the specific sub-assemblies to pick and in what quantities. The

operator would pick the sub-assemblies and then depress a button which indicated to the system the container was ready to move and at the same time used to maintain a real-time accurate inventory of our sub-assemblies. We also applied new systems to address product quality issues that had always been an issue.

At each operation, for example the keying station, we installed monitors that would display detailed electronic product build operator work instructions and critical assembly information that would lead operators through a well documented process that eliminated most build errors.

Supply chain/ electronic kan bans

Our goal was to move away from the often unreliable traditional MRP method of material planning and move toward a simpler kan ban replenishment method of sub-assemblies. As I mentioned before we had very good historical information about consumption levels of these sub-assemblies and how often, based on factors such as supplier lead times, that we would re-order materials. Based on the notion that we carried a real time inventory level within our system we utilized an electronic kan ban method to generate new orders for replenishment of materials. To make sure we gave our suppliers enough visibility however, to allow them time to procure raw materials and build their products, we utilized MRP to give a longer range forecast where we anticipated the business was going. This entire new supply chain process worked very well.

Results

Implementing a culture change, a completely new manufacturing process and system, and bringing it all together with essentially a new organization is probably the most fun I have had in my career. We were fortunate enough to have a great team in place that was able to address issues quickly as they arose and through tremendous dedication we were able to complete the new plant on budget and start it up on time. While, as expected, we had to struggle with start-up problems we quickly worked through those and were able to take our lead times down to about 10 days within the first few months. Our first pass yields and reworks improved dramatically while our inventories were reduced by several million dollars and our overall operating costs were reduced by about $4M annually (through reduced headcount, lower labor rates in North Carolina, and fewer front office resource requirements due to the improved systems).

Key Lessons Learned

- When starting with a blank sheet of paper, be innovative and think outside the box
- Make sure you have the right team in place

- Take time to really analyze data – dissect it and let it lead you to patterns you never anticipated
- Simplify everything – especially the supply chain
- Have fun

Contacts/references:
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Steve Oakes – Supply Chain manager

Flextronics

In 2000 I was recruited to Flextronics as Director of Operations for two facilities in Dallas, TX. This was a $100M business that was part of a multi-billion dollar electronics business producing metal enclosures and assemblies of electronics, cable, and interconnect products for the telecom industry. By this time the application and understanding of lean had come into the forefront and was already being practiced extensively at Flextronics. In fact, a global organization was in place to support the application of lean methodologies. This is where I learned more of the finer points of lean, primarily through manufacturing shop floor application of techniques as well as detailed training sessions.

Flextronics had fully embraced the main tenets of lean which included the elimination of waste through application of value streams, spaghetti diagrams, cellular manufacturing, 5S application, visual manufacturing, SMED, and tracking of key metrics.

When I arrived the culture was already well advanced along the path of transformation to one of continuous improvement. It was no surprise then that as the business started to grow we understood how to handle that growth without adding many resources. In fact, in the box build operations we were able to utilize our direct labor much more efficiently – from 10.9% of product cost to just 6.5% of product cost.

Key aspects of this organization were:

> **5S** – The entire operation was very clean and organized. Everything had a place and there was an identified place for everything that was needed. We utilized taped areas on the floor for standard WIP, clearly identified containers for small parts inventory, locations for progression builds of our metal enclosures, shadow boards for tools, and even identified spots for our trash cans. Everything was spotless!
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> **Standardization** – Standardization was a key component of lean at Flextronics. You could walk into any factory in any location in the world and see the same set

of metrics (arranged the same way on the metrics boards), the same color codes used in taped areas for identification of build locations in manufacturing cells, incoming inventory, scrap and defective materials, WIP inventory locations, and so on. In addition we standardized the use of certain operator tools for specific jobs – this allowed people to easily move from one job to another as well as minimize the number of spare parts and tooling required to support the operations.

Visual Manufacturing - Replenishment of material, moving builds to the next location in the build process, meeting takt time, notification of quality issues, etc. were facilitated quickly and effectively through visual manufacturing. Our goal was to be able to walk up to any area and quickly understand if the operation was functioning as required or if there were issues.

For example, in order to meet our production requirements we had to complete the build sequence at a specific location in our build process in a certain amount of time. To keep the process on schedule we installed timers at each location. If a location had 5 hours to complete a build the first 4 hours of the timer were green. The hour between 4 and 5 was yellow, and any processing time after hour 5 was indicated in red. It was then very easy for the supervisors, team leads, and operators to understand there was an issue to bring the proper focus to address the problem.

Kan Ban/Supply chain – Another tool in our kit at Flextronics was the application of a streamlined supply chain utilizing kan bans. The kan bans were established based on historical consumption levels, replenishment quantities, and lead times from our suppliers and included both internal replenishment (internal sub-assembly builds) as well as external suppliers. In some cases the entire supply chain was electronic in nature in that we would place orders directly through email or supplier sites without the intervention of our purchasing department. These systems are very simple in nature and allow much better control of standard inventory levels and eliminate fluctuations between lack of inventory and excessive inventory associated with typical MRP systems.

Cellular manufacturing – Elimination of batch and queue in our manufacturing was key to being able to leverage our resources, improving on time delivery, and reducing our inventories. Creating manufacturing cells in the box build process allowed us to break the process down into discreet process steps that created very specific operator actions, similar processing time between steps, and an overall flow process that reduced work in process inventory.

Results

Results in operations were broad based and included a 40% labor efficiency improvement, a doubling of inventory turns from 6 to 12, and an improvement in customer on-time delivery from 92% to 98% to our promise date.

Key Lessons Learned

- Eliminate batch and queue and move to flow processes
- Understand and produce to takt time
- 5S is the foundation of lean
- A CI support organization is critical to success of lean

Contacts/references:

Bill Biancaniello – General Manager Dallas Operations
Jeff Matzek – Supply Chain Manager

AMI Doduco

In my career, AMI Doduco has provided me with my greatest challenge in terms of introducing a continuous improvement culture and lean methodology to an organization. I was recruited to AMI to utilize my lean experience with the objective of changing a culture into one that embraced continuous improvement and that capitalized on organizational ideas from top to bottom.

For me there were 3 phases in this multi-year transformation process and there were no clear lines of distinction between these phases as each one transitioned into the next:

- **"What in the world is lean?"** - comprised the first 1 to 2 years
- **"I hear you but I'm not sure what you want me to do"** - lasted another 1 to 2 years
- **"This stuff really works!"** - started between year 3 and 4

What In The World Is Lean?

When I arrived at AMI I found an organization that could be described as obedient and compliant. It was a culture where most employees felt comfortable simply executing tasks - someone would tell them what to do and they would do it. There was not a culture of continuous improvement.

It was a business where executive management understood that change was needed but wasn't sure how to get there or what lean was all about, the kind of culture needed

to make it work, and the fact that to make such a transformation was not free (including people resources and funding).

In that environment it was difficult to get traction. There were few resources that could take a leadership role, the issues were complex, and initial changes were met with pushback which resulted in a number of false starts and a lack of confidence in lean. The first tool brought to the organization was 5S. For me, 5S is the foundation for moving an organization into a lean environment – without an organized workplace and without good housekeeping it is extremely difficult to gain momentum in other aspects of a lean transformation. While there were some early successes related to 5S there was just no overarching transformation process underway – we just couldn't reach a critical mass. What we needed was stronger upper management support, funding to implement some fundamental changes in the way we were doing business, and more resources to get the tools, practices, and message out to the masses.

We had 3 major manufacturing plants that needed our focus – Puerto Rico, Westmoreland (a western Pennsylvania facility) and Mexico City. I made the decision in early 2005 that we were at a make or break point in the process.

Without full management support, an organization and resources to provide support and to be in more than one place at one time, and funding to create manufacturing cells we would never move the process forward. I decided to work with a 3rd party support organization, TBM, that had built a strong reputation in supporting and helping organizations move forward with lean. I convinced our top management, including the CEO and CFO of our parent company, to attend a multi-day seminar with TBM. This seminar included a very beneficial "shop floor" simulation of the benefits of lean and how lead times, inventory levels and customer service could be improved. We were off and running – we used that seminar as the springboard to partner with TBM and to gain significant funding and the commitment to develop a formal support organization for lean.

I Hear You, but…

After getting upper management fully on board, my first action was to fill two key roles that had been identified as necessary to move the process forward. The first was the newly created position of Director of Lean North America. The second, to address business process improvement, was a position we called BPIM (Business Process Improvement Manager). These two key positions would focus on helping us create the continuous improvement culture we needed.

For the Director of Lean role I hired a gentleman that was the leader of Delphi's lean transformation across their European operations. And for the BPIM role I hired a young lady with a strong business process background who had held various quality management roles prior to AMI. In addition we created a support organization in the

Westmoreland and Puerto Rico facilities by adding a KPO (Kaizen Promotion Office) leader for each location. We were really beginning to gain momentum at this point.

Our next step was to utilize the knowledge and extensive resources of TBM. Working with them, the Director of Lean and our BPIM, we created a roadmap of how to move forward in our transformation process. At about the same time we had just closed a facility in eastern Pennsylvania and moved most of the production into our plant in Puerto Rico. The influx of this new business, as well as significantly increased product demand, created issues in Puerto Rico that negatively affected our on-time deliveries (down to 50% in some cases) and our scrap rates to increase to more than a $750,000 annualized rate. We decided to focus our lean efforts first in Puerto Rico. The first step was to replace the plant manager, who was unable to change his management style to address both the chaos associated with the plant consolidation and display the leadership needed to transform the culture, to one that had a strong background in lean implementation and could lead the transformation process locally.

To accelerate the transformation from a batch and queue business comprised of "process islands" (such as all press machines in a single room), with high scrap rates, long lead times, significant WIP inventories, and inefficient labor we held a Vision Kaizen at the end of 2005 to lay out the basic details of how to transform the plant. This led to our overall blueprint and strategy for moving forward.
The first step was to define Product/Process Families where nearly every product made (>95%) could be placed into a family that was based on common processing steps that were required to make the products. Typically this included powder making, powder metal pressing, sintering operations, infiltration, solder flushing, cleaning, packing, and so forth.

As part of the Vision Kaizen we analyzed our equipment and assets to determine if we could create dedicated manufacturing cells that would allow us to produce a family of products in a streamlined product flow fashion – no more high volume (batch) production in one process area only to inventory it then sometime later move a piece of that production to the next process island. What we found was that we could identify 5 Product Families that, with minimal equipment purchases, we could support by creating 5 dedicated manufacturing cells. Our 6^{th} cell was a support cell that prepared the powder mixtures for each of our 5 cells. With these cells and our plan we were on our way.

Each series of equipment moves to support the cells were completed as part of a full week long kaizen event. Considerable advance planning occurred in advance of the week where the final analysis was used to refine the layout, where we would physically move equipment and create the cell, then start up after the move and eventually celebrate success.

Over the next 9 months we rearranged the entire plant to support the Product Families and our new way of doing business. These cells and equipment moves, however, were only a small part of the continuous improvement culture we were developing. We also needed new systems that would support our way of doing business, new metrics, a way to drive financial results to the lowest levels of the organization, a new plant floor team structure, and a means of accountability to tie it all together.

This Stuff Really Works!

The pieces of the puzzle fell into place in this phase and the team, from management all the way to the shop floor, really started to believe in what we were doing - and the effort showed up in the results. We developed a set of standard metrics for each cell:

1. Safety Incident rate
2. Customer Returns
3. PPM
4. Sales/Employee
5. Work in Process inventory
6. Scrap
7. On-time delivery

These metrics were reviewed frequently through a "Daily Walk Through" process.

The plant manager, along with the head of each functional group in the plant would spend about 1 hour each day walking through each manufacturing cell and reviewing data from the prior day with the supervisor, team leader, and key operators. This daily walk through became the basis for achieving truly significant results in our continuous improvement process. First, it provided important data to management and the shop floor in real time – issues were identified quickly. Second, we developed a Kaizen Newspaper process where anyone, and in particular shop floor operators, could document issues (the old fashion way with pencil and paper) at each cell and during the walk through the plant manager would review those issues and assign a functional group leader to determine root cause and corrective actions with specific due dates. To me, this was the single most important aspect of creating buy in at all levels – the shop floor teams now had a mechanism to communicate issues and also had a forum of accountability in which to get the needed results. This process of a daily walk through and the Kaizen newspaper, for me, can be credited with the overall culture change we were seeing in our plants.

By this time 5S was an important aspect of what we were all about. We spent time and money on better lighting, cleaning up the place, and organizing our shop floor. Soon the results were like an avalanche – once we reached critical mass the improvements accelerated, the team felt great about the accomplishments, and success was

contagious. Some of the key metrics we looked at (and in the overall plant there were many more than the standard 7) saw marked improvement in 2007 compared to 2006:

	2006	2007
Safety Incident Rate	1.9	1.9
Customer returns	< 0.2	< 0.2%
PPM	**34,918**	**11,654**
Weekly Sales per employee	$1620	$1880
WIP	**$203,000**	**$ 78,000**
Scrap	**$722,833**	**$262,998**
On-time delivery	**72%**	**96%**

While we were rearranging the plant we were also putting best practices in place to take advantage of the momentum. One great example of this was creating a new financial tool to drive understanding of financial results to the lowest levels in the organization. For most, a plant P&L is confusing and if you are a plant supervisor, team leader, or operator you really do not have a clear understanding of how you affect that P&L. Working with the finance organization we developed a tool we termed Cell Financial Performance. This monthly statement was a very simplified financial accounting of each manufacturing cell's financial performance but without the typical standard cost accounting methods of developing the P&L. This statement simply looked at output production (based on sales value of product produced), the actual cost of direct labor to produce it, the value of direct material consumed (including scrap), and other costs associated with repairs and maintenance, supplies, etc and a few allocated costs from other departments (such as the powder making cell). The resulting simplified P&L was reviewed by the supervisor with each cell to develop actions to make their cell more profitable month over month. These proved very beneficial as you can see in the results shown above.

While the successes discussed above were primarily achieved in our Puerto Rico facility we saw similar benefits as we started our full scale lean transformation in our Westmoreland facility. A prime example included a dedicated processing cell, created through a week long kaizen event, with about 90% of the cell production dedicated to one customer. Historically, we had a commitment of 10 week lead time to this customer. And since it was difficult to know what their customers wanted the following week, our requirement for them to place orders 10 weeks out led to a lot of order changes, order starts and stops, and confusion, with our on-time delivery typically less than 90%. Our new model was a dedicated line with streamlined product flow with 5 day lead time commitment. This new model required support from our customer in terms of their order processes (they now ordered every Friday and we delivered the following Friday), belief that we could actually improve delivery while reducing lead times, and the need to add strategic inventory of some sub-assemblies. The end result was first and foremost a very satisfied customer that ultimately led to incremental business – this was realized through our ability to consistently deliver their orders in 5 days with a 100% on time delivery record!

Finally, from a systems standpoint we made the decision that our long held ERP system did not have the proper tools to support our new flow processes and the way we wanted to manage with pull systems for replenishment, visual manufacturing, and overall production planning. I had identified a new system during one of my benchmark visits, Microsoft Axapta, that fit our needs very well. It allowed for the new planning processes, capacity evaluation, and generation of promise dates to our customers, and so on. This system was implemented in about 6 months, completed mid-2007, and became the basis for the systemization of our lean initiatives (Appendix A).

Key Lessons Learned

- Need management support all the way up to the CEO
- Lean is not free – need adequate resources – both people and funding
- Stay the course – adjust to early failures and keep moving forward
- 5S is foundation for your lean implementation
- Need the right people with you on your journey – KPO leaders, CI leaders, Operational leaders
- The lean journey never ends
- Training at all levels of the organization is critical – people need to understand lean
- Kaizen events are the means to transform
- Don't measure the success of a kaizen event strictly by direct financial impact – this is truly a case where the sum of the whole (all kaizens) is much greater than the sum of the parts
- Momentum and critical mass are important
- Ownership must be driven to the lowest levels of the organization
- Provide buy-in tools for all levels of the organization (ie, Daily Walk Through)
- Utilize all tools in the Lean bag (such as Total Productive Maintenance)

Contacts/references:

Bev Fazio-Keller – Controller North America
Eric Schriver – VP Sales & Marketing
Mike Taccino – CIO
Pablo Gonzalez – Plant Manager in Puerto Rico

Appendix A

Technitrol Selects Microsoft Dynamics to Drive Lean

Manufacturing Initiative for Subsidiary AMI DODUCO

Microsoft Gold Certified Partner mcaConnect implementing ERP platform to assist manufacturer's efforts to reduce costs and streamline production schedules.

EXPORT, Pa. — Dec. 5, 2006 — In a global economy, management increasingly relies on technology to provide real-time visibility of key performance indicators across a number of business segments to make informed decisions. Microsoft Corp. (Nasdaq "MSFT") today announced that AMI DODUCO Inc., a subsidiary of Technitrol Inc.(NYSE: TNL), has selected Microsoft Dynamics™ AX to serve as the central financial and supply-chain management technology supporting an effort to implement lean manufacturing principles within AMI DODUCO's North American operations. A selection committee, composed of executives from Technitrol and AMI DODUCO, conducted an extensive evaluation process to determine costs associated with upgrading the legacy SAP R/3 ERP system as compared with moving to a new Microsoft Dynamics AX system.

"AMI DODUCO has a responsibility to Technitrol and its customers to deliver product in the most reliable, timely and cost-efficient manner possible," said Bill Foughty, vice president of the North America Business Unit for AMI DODUCO. "We believe that technology can play a big role in reaching these goals. We sought a solution that could provide our organization and our parent company with visibility into our operations for a lower total cost of ownership than our existing SAP UNIX/Oracle system."

AMI DODUCO manufactures electrical contacts for use in circuit breakers, staked and welded assemblies, and mechanical rivets for electric motor and equipment manufacturers around the globe. The company uses precious metals in the manufacture of its products, and tracking the acquisition costs and market value of these materials is a significant component of its financial health and profitability. The solution, which will be implemented by Microsoft partner mcaConnect LLC, will streamline the manufacturer's financial and operational data onto a single IT platform, providing management with the data required to achieve a lean manufacturing environment.

“Our lean manufacturing initiative is already reducing waste in a number of ways, but the savings we will realize from reduced maintenance and administrative costs made Microsoft Dynamics AX a very attractive solution,” Foughty said.

Total cost of ownership (TCO) — sometimes referred to as total cost of operation — is a financial estimate designed to help businesses assess direct and indirect costs related to the purchase of any capital investment, such as ERP software. TCO assessments reflect not only the costs of acquisition but of all aspects in the further use and maintenance of the system, such as those associated with employee training, outside consulting, system failure, security breaches, disaster recovery, and development.

Based on the familiar People-Ready 2007 Microsoft Office system interface, Microsoft Dynamics products are easy to configure and maintain, further adding to overall return on investment.

About Microsoft Dynamics

Microsoft Dynamics is a line of financial, customer relationship and supply chain management solutions that helps businesses work more effectively. Delivered through a network of channel partners providing specialized services, these integrated, adaptable business management solutions work like and with familiar Microsoft® software to streamline processes across an entire business.

About AMI DODUCO

AMI DODUCO is a global leader in electrical contact technology and fabrication. The company supplies contacts and assemblies, contact materials, electroplating and surface treatment services, and precious metal refining and recycling to more than 3,000 customers. AMI DODUCO operates from locations in North America, Europe and Asia.

The company’s website is www.amidoduco.com.