SURGICAL TOOL MANUFACTURING LEAN INITIATIVE

A Case study adding to the body of research of Performance Improvement specifically relating to Gilberts work in "Human Competence- Engineering Worthy Performance"

Joe Boyle

Northern Michigan University

Professor Robert Lion

Improving Human Performance - PYTD525RL

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Abstract

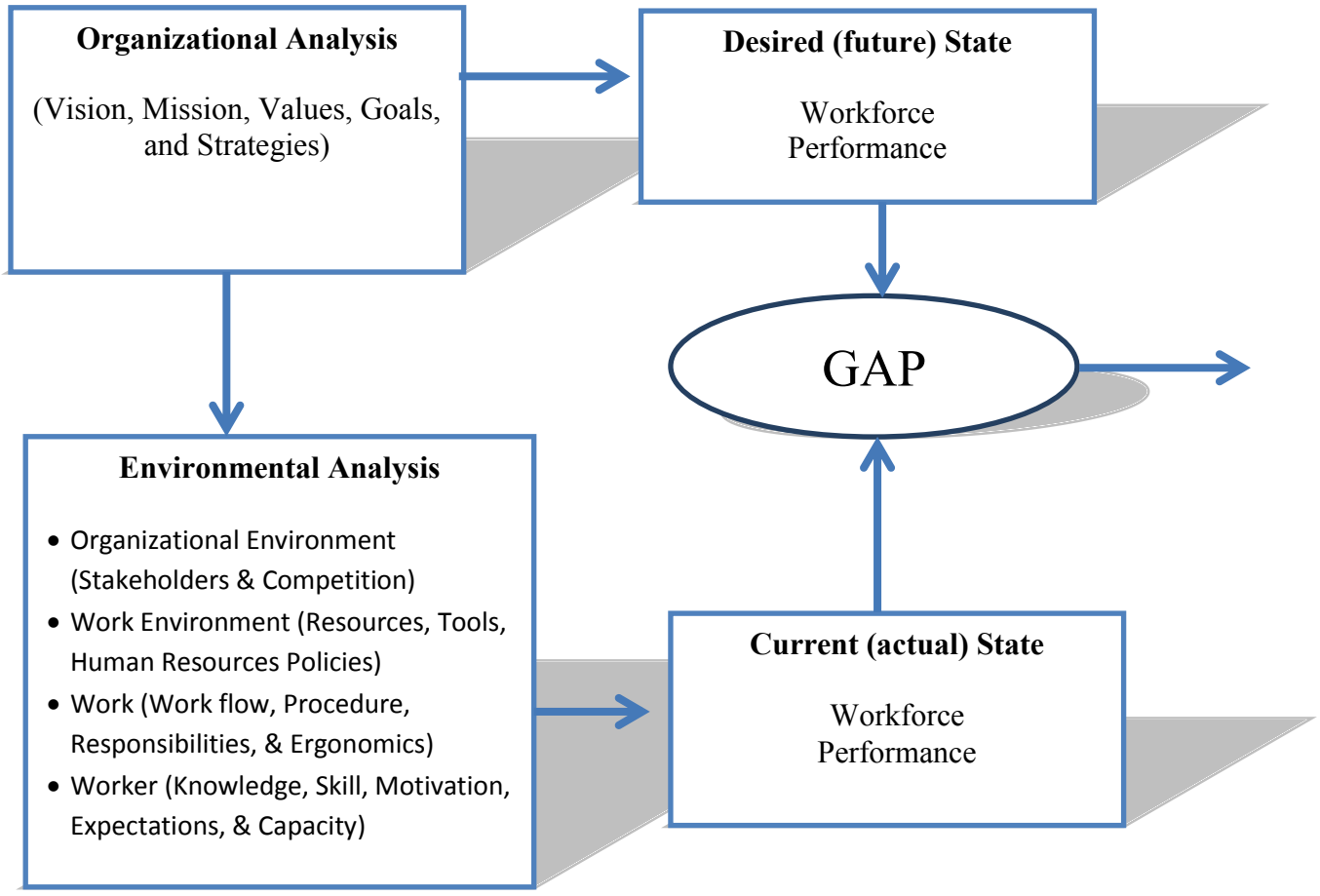
This study adds to the body of research of Human Performance Technology specifically relating to Gilberts work in Human Competence- Engineering Worthy Performance. Although the Company name was changed, SURGICAL TOOL MANUFACTURING provides a real life example. By studying the performance improvement process at a small rapidly growing manufacturing company located in Michigan's Upper Peninsula, we observe the transition from an entrepreneur owned company to a corporately structured enterprise struggling through the stresses induced by rapid change. The project employed Gilberts Behavior Engineering Model (BEM) documenting each phase including Performance Analysis, Cause Analysis, Intervention Selection, Intervention Implementation and Evaluation. The improvement efforts intended to produce outcomes of sustainable performance improvement and cultural change, but what was most important was the ability to link behaviors and performance improvement efforts to improvements of key performance indicators and bottom line financial outcomes.

Introduction

In 2008, I met Dave Pelizzon and without his leadership, this paper would not have been written. Dave, sometimes call the Colonel, had an Army background and much leadership training. He focused intensely on outcomes. Although representing investors, Dave had taken over as acting general manager and over a 3-year period, he struggled to improve SURGICAL TOOL MANUFACTURIING. Dave saw positive changes, yet the change was not fast enough and he could not sustain his intense efforts needed to continue. The effort to transform the company was sapping his strength and resources and it just was not fun anymore. Dave needed help from a number two, or performance technologist-manufacturing engineer, to help make the noise go away.

Larry Linne in "Make The Noise Go Away: describes the value of a second in command can bring to making the noise go away: Provide upward communication, allowing Dave to do what he enjoys best and keep him informed. Help establish priorities and stay on track. Bring new ideas and value to the business. Be the one losing sleep over the business. Understand customer needs. Find ways to make the leader and company look good. Lead others to do things versus doing everything by self. Solve problems. Get results. This relationship between the leader and performance technologist-manufacturing engineer provides the most impact to the success of a performance improvement effort. This symbiotic relationship is critical- the leader leads the direction picking the right things to do. The PT or manufacturing engineer helps the leader do the right things the right way. In addition, human performance technology is critical in the continuous improvement process. In writing this paper, I find that I am a very effective number two and this is where I should focus my efforts.

HPT Model: Performance Analysis Phase



Performance Analysis

Organizational Analysis- The organizational analysis helped define the "Desired Future State". It included these elements:

- **Vision-** Profitably grow- become the preferred provider of surgical tools to physicians worldwide.
- **Mission-** SURGICAL TOOL MFG is dedicated to design and manufacture of surgical tools and accessories that are second-to-none in quality while providing exceptional value to customers.

- **Values –** Mutually beneficial relationships based on honesty, fairness and integrity in all transactions with all stakeholders- Investors, customers, suppliers and employees.
- **Goals-** Profitable growth. Flow. Reduced Lead times, Improved Quality
- **Strategies-** Reduce waste and non-value adding time and activity that add cost and lengthen lead times. Reducing waste creates capacity at little cost. Top leadership and investors feels confident they can increase sales by reducing lead times and fill newly gained capacity with profitable sales.

Environmental Analysis- Current State

Stakeholders include the investors, employees, customers, and the community. The investors, a privately owned equity company sought long-term return on investment. Employees wanted security during a highly turbulent time, adequate pay, health benefits, and flexibility. Customers needed surgical tools of high quality, low cost, delivered on time and wanted innovative services that help them be more effective. In addition, the community relied on continued economic benefits provided by the largest private manufacturing company in the area employing over 120 employees.

Competition

To analyze the competition we employed a SWAT analysis. Strengths included, quality systems needed for medical devices providing some protection, blocking entry for new competitors and offshore competitors. SURGICAL TOOL MFG is capable of producing low volume, high variety products, on short notice. Capital is available to make improvements.

Weaknesses included location in UP has advantage and disadvantages such as lower cost of labor, but located further from customer and supply base.

Opportunities- Highly competitive market provides an advantage to the nimble- ability to deliver in short times of low volume, high variety surgical products provide an opportunity to grow profitably.

Threat- Off shore providers could make surgical cutting tool products using traditional cutting tool manufacturing processes with little modification to quality systems. Threat of these low cost manufacturers could prove disastrous.

Work Environment

Investors provided needed capital for resources to make improvements, implementing ultra modern tools and building new facility. Human Resources developed policies and provided effective HR system. A functional layout with batch and queue processes caused poor information and material flow, long distances between work areas, long lead times, and excessive inventory. These elements hid quality problems resulting in high quality costs, poor on time delivery, and high work in process inventory. A young ISO quality system in place with documented policies, procedures and work instruction current. (see appendix A- process maps and flow diagrams or current state)

Worker

Note this study did not focus heavily on Individual Repertory of Behaviors (Knowledge, Skill, Motivation, Expectations, Capacity) Although operators would need to expand their

Technical skills such as CAD, CNC Programming, Tool Design, Machine Operation, Quality Systems, many of these skills could be acquired with on the job training. Senior managers realized team process, communications, visual controls, and JIT – trainings would be needed as major changes were coming. Much of this training could be done while completing kaizen events with focus on keys to continuous improvement - clean organized work place, all team members understand how to recognize waste, and standardizing the process.

Gap Analysis

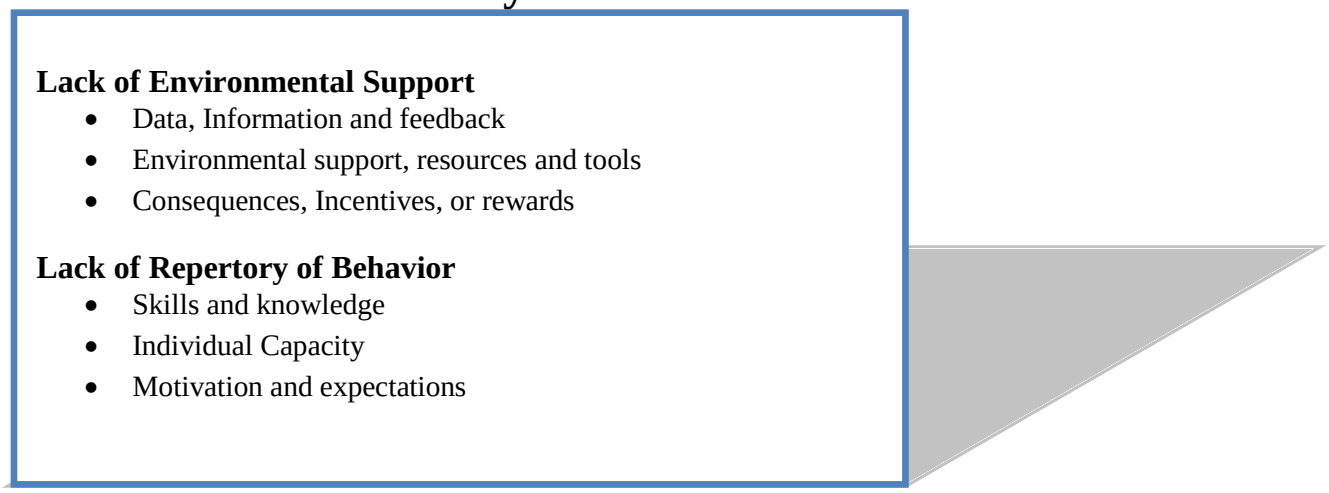
Opportunity Calculator (See appendix B for complete spreadsheet with financial inputs). The opportunity calculator provides a tool to help leaders decide as to where to focus improvement efforts to gain most benefit. The model based on common financial metrics and in most cases, data is already available. In this model, we take a conservative approach assuming no increase in sales and moderately increasing inventory turns. The model shows the metric that will have the most impact is improving inventory turns. Increasing turns provides an annual benefit of over 2 million dollars and a one-time conversion to cash of over 13 million dollars. This is low hanging fruit and why we chose to focus on environmental issues rather than on individual repertory of behaviors (Knowledge, Skill, Motivation, Expectations, and Capacity).

Key Performance Indicator	Current State	Improved Future State	Annual Benefit	One Time Conversion To Cash
Days Receivables (Days)	57.49	35.00	$99,808	$1,108,973
Employee Turnover %	23%	10.00%	$105,[illegible]	
Inventory Turns	1.0	10.00	$2,279,714	$13,410,080
Machine Uptime Hrs Avail(%)	60.00%	85.00%	$535,500	
On-Time Delivery (%)	80.00%	99.00%	$342,076	
Premium Freight ($)	$9,360	$4,500	$4,860	
Schedule Bumping %	15%	5.00%	$85,680	
Scrap and Rework (%)	4.0%	1.00%	$435,158	
Utilities ($)	$266,400	$250,000	$16,400	
	Summed Benefits		$3,905,010	$14,519,053

Income Statement	Current State		Future State	
Annual Revenue	$18,000,000	Note: this model assumes no change in Annual Revenue. Reset the model and run again with new Annual Revenue estimates for what-if scenarios.	$18,000,000	
Cost of Goods Manufactured	$14,399,200		$10,494,190	Annual Benefit
Operating Margin	$3,600,800		$7,505,810	$3,905,010
Operating Margin %	20.0%		41.7%	21.7%
Balance Sheet				One-Time Benefit
Average Inventory	$14,850,000		$1,439,920	$13,410,080
Receivables	$2,835,000		$1,726,027	$1,108,973

Use the attached spreadsheet found in appendix to create what if scenarios, for instance best case, worst case, most likely. The blocks in yellow indicate cells where you may change the inputs. The cells in orange/brow indicate calculated outputs.

HPT Model: Cause Analysis Phase



Lack of Environmental Support

To complete this section we will need to revisit the Analysis Phase to determine the root causes of performance gaps.

Data, Information and feedback

Prior to the Performance analysis, information was not readily available on a timely basis. Accounting combined financial metrics for operations into one big account, obscuring problems and making it hard to understand key metrics for each product line. Other than accounting measures such as profit, cash flow and loss of sales due to poor delivery, performance standards did not exist. For the most part, financial data had little impact on worker performance. Large batches exacerbated problems by causing longer lead times and hiding quality defects. This in turn caused unacceptable customer satisfaction levels and lost sales. The Gap analysis and Opportunity calculator showed clear areas for improvement: Increasing inventory turns by far has the most opportunity for impact in terms of real dollars- Annual and one time conversion to cash.

Although registered to ISO Quality System standard, with many policies, procedures, and work instructions documented, little was done to analyze the effectiveness of the work and scant documentation was available in terms of key operational metrics. The Quality System was young and SURGICAL TOOL MFG took an approach "*we documented what we do and do what we say*". What documentation was available provided little use because accounting practices did not break out operation accounts by product line.

Feedback from the investors and customers provided a consistent message – "we are losing business because our lead times are too long". This stymied the vision of profitable growth and to becoming the preferred provider of surgical tools to physicians worldwide.

Our study found no evidence of process maps to expose waste. Operations clung to a mass production paradigm, batch and queue, as an efficient means to making product. However, in a batch and queue environment, although things always appeared busy, there were no performance standards driving improvements and much of the busyness was non-value added activity. Even though we could witness much pre-made WIP inventory, overtime hours were high.

Consider all the wastes associated with over production and inventory, ties up cash, requires floor space, consumes resources for counting, moving, controlling, racking. Parts had shelf life causing shrinkage. Large batches create long lead times waiting for parts and batches hid problems, one of the most costly in terms of wastes. These activities associated with inventory are all non-value adding – They are wastes that the customer is not willing to pay for and must be rooted out.

Nevertheless, this does not tell the entire story- SURGICAL TOOL MFG is losing business due to long lead times. Improving inventory turns will also improve/shorten delivery time, improve quality costs and spur profitable sales. New process maps showed non-value added time and activity at 95% non-value added time and activity- mostly where parts sat waiting in queue for the next process.

Environmental support, resources and tools

Investors supported the organization with needed financial resources, tools, and equipment, but the operations team at the plant did not recognize deficiencies of a batch and queue process lay out and the inadequate working conditions it provided. Consider if operations eliminated all the wastes associated with over production and inventory created in a functional layout. What would be the effect on the company? - It would be huge! Resources were readily available but not optimally arranged for flow and most people felt overwhelmed by day-to-day fire drills to think about making major plant layout changes.

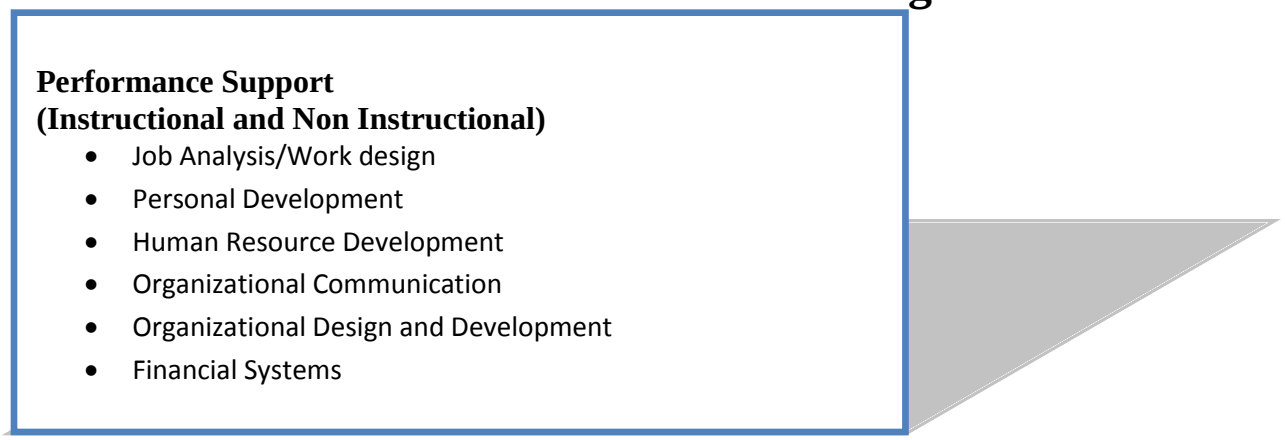
Consequences, Incentives, or rewards

At the beginning of the analysis, work was not related to profitable growth – in fact many in the company wanted to stay small with less stress. Growth may have been seen as an extra form of unwanted stress. Only top-level managers received performance-based rewards. In many cases, poor performance was rewarded because mid level managers encouraged overproduction to keep utilization of labor numbers up- one of the worst forms of waste. At one point, the investors told me "Joe we have been trying to turn things around for three years. Our patience has been

exhausted. This is the last effort we will put into this plant. The investors were fair, yet demanding. One investor with military training told me "Joe, do what you need to. In fact you let me know if anyone gets in the way"- Using a military term he said "I will shoot one to make an example to all. Lead times cost and quality must improve." Talk about motivation!

The initial analysis showed huge opportunity by improving environmental supports. Due to this and short time frames allowed we did not focus heavily on the lack of repertory of behavior of individual skills and knowledge capacity and motivation.

HPT Model: Intervention Selection and Design Phase



Intervention Selection

There are so many interventions to choose from, SURGICAL TOOL MFG needed to narrow the focus based on the cause analysis and performance gap analysis. SURGICAL TOOL MFG chose Action Learning as the main performance improvement intervention that would improve the situation. Under the Action Learning umbrella, we choose several supporting interventions focusing in these areas:

1. Financial Systems
2. Organizational Design and Development
3. Job Analysis/Work design
4. Mentoring and Coaching

Action Learning Intervention

SURGICAL TOOL MFG faced complex problems spanning several different functional areas including not only shop floor functions (milling, turning, electro polish, laser etching, grinding …) but also front office functions such as engineering, accounting, production control, sales, and quality. The interventions would require representatives from the different functional areas

to apply knowledge to create effective future performance and create buy in during implementation. We knew teams would wrestle with problems, balancing day-to-day production needs, choosing alternatives, and setting priorities for improvement efforts. It would be essential to employ a mentor/coach/facilitator, expert in team process and lean manufacturing concepts, to guide the team's improvement efforts. The action learning approach attacks common problems and tasks using a learn-by-doing approach. Instead of brain storming, teams would be encouraged to use try-storming. The goal was to not only make improvements, but also result in learning and development of group members so they could continuously improve and improve quickly. An area of the plant was set aside to build mock ups. RIP teams (rapid improvement teams) were expected to act – instead of waiting for expensive lab furniture such as tabletops and containment booths, teams quickly made these items using readily available materials from local hardware stores. These items could be custom fitted and changed out quickly. When homemade items proved out satisfactory – professional quality lab tables and furniture could then be substituted.

Financial Systems

Company leaders could better deal with economics and make decisions based on relevant and timely financial information. To this end, we chose to employed financial systems interventions cash flow analysis to guide capital investment and spending. The Opportunity Calculator provided a great analysis tool that clearly showed opportunities in one time conversion to cash and annual financial benefits. (see appendix A)

With the financial analysis complete SURGICAL TOOL Manufacturing could then chose to invest the money gained from eliminating inventory to build capacity, for instance; by

purchasing right sized process equipment, placing smaller right sized equipment in focused factories that would enable material and information flow. Microwave oven sized laser etchers used to mark identification on product replaced the need for batch and queuing product to the laser etch department. Creative employees devised a way to replace the large electro polish tanks (a separate batch operation that required a large room) using off the shelf components, inexpensive crock-pot to heat solution and a battery charger to provide current. This right sized equipment easily fit in the focused factor and eliminated batching. We knew reducing work in process inventory would eliminate other wastes and help expose problems more quickly, while at the same time reduce lead times- a factor key to profitable growth. This leads us to the next performance improvement intervention, Organizational Design and Development.

Organizational Design and Development

We chose Organizational Design and Development interventions to link strategic plans for profitable growth with Reengineering, Realignment and Restructuring the entire organization. Reengineering the batch and queue production process to flow production, (focused factories/factories within factory) would make information and material flow. High value, high quality product, delivered fast, provided the strategic key to profitable growth. The huge changes required by Reengineering, Realignment and Restructuring the entire organization in turn required team building, problem solving and decision making interventions in a highly charged action learning environment. Reengineering would affect all functional departments in the value adding chain and in turn lead to needing Job Analysis/Work design performance improvement interventions including front office functions such as accounting methods to better understand financials by product line.

Job Analysis/Work design

Reengineering, Realignment and Restructuring the entire organization placed huge demands on the organization and its people. We chose several components of the HPT model in Job Analysis/Work design interventions. Job descriptions change. Workers in new production layouts (they helped design) learned new skills, rotating through different jobs in a cell, and enlarging their job knowledge. Work methods changed from batch and queue work methods to small lot production, JIT and one-piece flow. Team members in a cell learned to employ quality control tools to improve quality. In developing the new flows, team members to learned continuous improvement methods and value engineering to determine what adds value, and how to eliminate non-value added activity and time. To ensure quality and continuous flow, team members employed preventive maintenance. In addition, to keep with company values of maintaining a safe clean, organized work environment, principles of safety engineering and ergonomics were implemented. All the interventions come under the umbrella of action learning- the company used a fast paced, learn-by-doing approach guided by a skilled facilitator or Mentor. We used very little formal classroom training.

HPT Model: Intervention Implementation and Change Phase

The SURGICAL TOOL MFG Performance Improvement Initiative employs all four parts of the HPT Model: Intervention Implementation and Change Phase including Change Management, Process Consulting, Employee Development, and Communication, and Networking and Alliance Building. Each codependent phase addresses closing the organizational and individual performance gaps between the current and desired future state. The measures of success are found in the transformation planner and hinge on SURGICAL TOOL's ability to improve lead times, on time delivery and quality.

Change Management

During structured interviews with SURGICAL TOOL Manufacturing, (ref A Video) employees discussed concerns and feelings about change efforts. SURGICAL TOOL MFG, a small entrepreneurial company grows at an extremely fast pace, requiring new systems and methods and creating stressful change for all employees. Investors have lost patience with the rate of positive change and the operations people have been in a storming stage for way too long. Reengineering a plant from batch and queue process layout to flow production requires major changes in floor layout and information flows. Traditional

> "*Like with any difficult change, everyone was not going to adapt to it*" HR manager

roles supervisors played to keep people busy needed to change to focusing on outcomes of improved delivery and quality.

Key groups from all levels need to be involved- from order entry, purchasing, scheduling, engineering, manufacturing, maintenance, quality and shipping. Employees have been working on change for several years and felt overwhelmed as new and even more changes were yet to come. Production workers, team leads, engineers, accountants and supervisors all felt the effect from the changes.

Although the role of change manager had evolved from command and control, to facilitator, executives at the head office provided strong encouragement, focusing on outcomes. The leader spearheaded the change movement and excused anyone unwilling or unable to make the changes the company needed to move forward. Some people left by their choice, some people the company asked to leave. This was a survivability issue. Many of the people involved in the change effort knew the changes were considered necessary, yet they needed the added coaching and facilitating to boost confidence levels and to make the changes.

Nurturing ownership would be necessary to long-term sustainable changes. "People support what they help create". Metrics in the opportunity calculator provided clear outcomes in terms of improving performance. The teams on the floor had autonomy in creating new focused factories. The facilitator used indirect methods, asking probing question of the teams "what would happen if?, and fostered involvement by asking team members to take turns facilitating team meetings.

Resistance to making changes was expected and most understood how this could undermine success. Many employees who started with the company when it was a small machine shop felt threatened. Machine operators used to running one machine very well, felt discomfort, as new workers seemed much more comfortable learning new skill sets and running different machines within a work cell. Supervisors' roles changed as well as hourly team leaders took on more responsibilities. Supervisors went from focusing on one process, signing time cards, and keeping the peace, to understanding what it took to make a component from start to finish as well as take on quality responsibility for the entire process. As inventory levels dropped problems were exposed and some people claimed this was a result of the new methods. The problems were there before just hidden, the metrics showed a bump in quality cost as workers adjusted to their new roles, but then we saw a dramatic drop in quality defects as focus factories members adjusted to the new production demands, methods and new equipment.

Teams needed to learn how to use new tools for team problem solving and communicating between shifts. We used a learn-by-doing process to implement spaghetti charts, fish bone diagrams, process maps, 5 why's, DMAIC, process control charts, pictograms showing areas of defects, force field analysis and statistical controls.

Initial work cells were prototypes, targets were developed as we discovered the bottlenecks in each cell- the pace setter of the work cell. Much focus was put on the bottleneck processes and processes that required product to leave and return to the work cell. Some machines had enormous capacity while others could not keep up. Work cell members were surprised when

they were asked to slow down a process to balance out a line, "but I can run the machine10 times faster? The answer was, "yet we don't need 10 times the parts- we only need the rate at which the slowest machine in the process can go". Gantt charts and schedules on the first work cells were very simple with short term goals- what will the cell look like after the change, and what do we need to do today to make it happen – while still producing parts and trying to meet schedules. We missed the opportunity to benchmark with the teams. This would have really helped teams see the future.

Process Consulting

For many at SURGICAL TOOL Mfg, the batch and queue process layout became entrenched, for it involved many departments and processes and these methods worked well in the past. The paradigm or model was set. Anything that agreed with the batch and queue model was accepted; things that did not fit the model were ignored or rejected. All did not readily see the need for change, problems were hidden, and traditionalist resisted changes. The ambiguous nature of the change effort with many departments affected, stymied previous change efforts. Process consulting was needed to promote changes that were log jammed due to departmental turf wars.

A kaizen coach promoted coordinated sustained changes. The coach helped the team understand group dynamics, brought insights that bolstered confidence –"yes this is the right thing to do", or encourage even bolder attempts at making work cells flow or reduce footprint pattern, "move the machines closer". It also helped leaders understand the potential gains that eliminating waste would bring and matching performance to business needs. This helped when teams needed investment in new smaller right sized machines. It was time to cut the cords on the machines of

the batch and queue layout, stop production and create new efficient process flows by product line. Focused factories- factories within factories that employ more machines, right sized for the work cell needs. Chaos and anxiety came with the major changes. The coach helped stabilize the process, bolster confidence and encourage workers in their change efforts.

For the Performance Technologist, the beginning phase can be an anxious time of getting to know the leaders you may work with. Making first contact can be intimidating. Working together with top leaders, you help clarify the need for change – in some cases the leader already knows change is imminent; your job is to help clarify the needs, determine if the organization is ready to change, and to show competency that you can meet the challenge. Chemistry between you and the leader is vital. A team of coaches with varied areas of expertise can help make this part easier.

In phase two, we formulated a contract and started building a mutually beneficial relationship. The client and coach defined the problem and agreed on the likely outcomes. On many of my engagements, this was hard – the client did not know what they wanted, yet insisted on fixed priced contract with guaranteed outcomes. In this case, it is best to provide a broad estimate on time and energy needed (from both sides needed) for the project. We used the opportunity calculator to develop a baseline reading and consensus on measuring success. The calculator allowed us to see worst, best and most likely outcomes.

In Phase 3, we did not need a force field analysis – the top leader already took over the plant manager's job and was ready to go, he already decided to proceed. In fact, the most successful

interventions I have been involved with are because the top leader was so passionate and supportive of the change efforts. We proceeded directly to phase four setting goals and planning project goals of how to reduce lead times and improve quality.

In this project, the phases blended and phases overlapped. In phase 5, we started the implementation process and the top leaders provided needed resources, many times pushing me to invest heavier and faster to speed the change process, or make sure support people were available. Money for resources was never an issue. The opportunity calculator provided confidence that we could reduce inventory levels by several million dollars, providing a one-time conversion to cash and annual benefit. We used this money to invest in needed resources that helped the company convert from batch and queue to flow production.

On all my projects, a major success factor was being there, open and visible as part of the improvement effort, giving and receiving constant feedback on the change effort progress and then making changes to adapt the change effort plans. An area I need to work on is phase six Contracting Completion. After months of hard work and long days, you feel just like taking a breather. This is not the time to rest but a time to set a legacy- how do you keep the process changes going after you leave. Old habits are hard to break. In many cases once the leader who spearheaded the Lean Enterprise initiative leaves the organization, the organization can fall back into old habits quite quickly. At this point, we need to understand who will be responsible for the continuing change efforts, its budget, and a planned celebration and set up a periodic maintenance plan that will ensure a long-term relationship.

Employee development

SURGICAL TOOL MFG's change initiative required all employees to learn new skills. Accounting needed to learn activity based accounting methods. Engineers learned about design for manufacturing and using datum dimensioning and tolerancing. Machine operators needed to learn how to become a cell operator becoming proficient in many different processes within the focused factory. Supervisors and team leaders needed to learn new facilitation skills as well as learning new methods for making parts. Material handlers learn to use and employed kanban systems. All had to understand the basics of continuous improvement- clean organized workplace, how to identify and eliminate waste and how to standardize a process. We all needed to learn and practice new team, communication and problem solving skills. Much of this development was handled on the floor with learn by doing techniques and lunch and learn sessions. A coach guided the process, and encourages others to help teach others. Many times team members rotated through the facilitator role, uncomfortable at first, then as they became more familiar with the process they became willing participants.

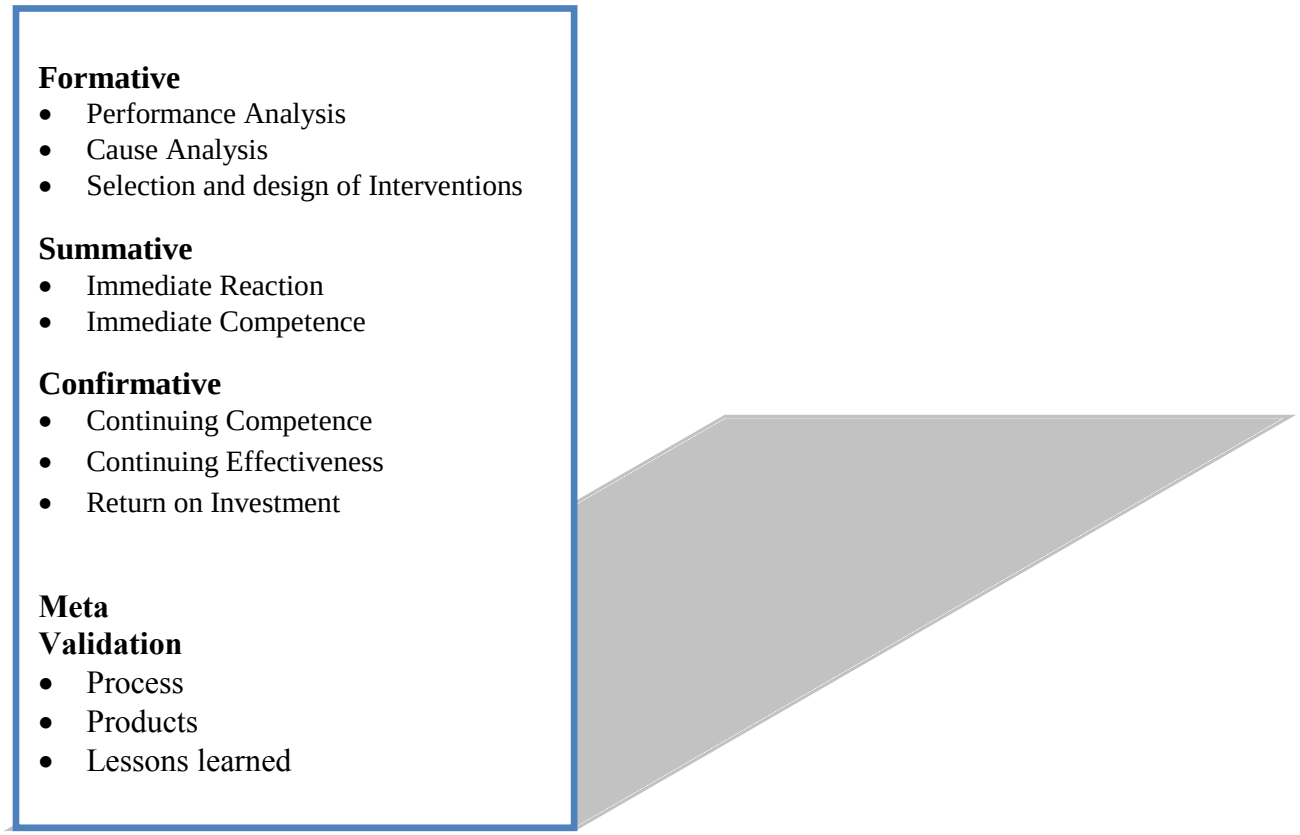
Communicating, Networking and Alliance Building.

Although improving communications did not present itself as a measurable outcome, effective communication is essential to any successful intervention. Our teams addressed improving communications much as we did the other improvement training, by using lunch and learn format, coaching opportunities on the shop floor with lean facilitator, and coaching from our teammates. For instance when developing a team charter, we reviewed communication strategies, how to conduct effective meetings as well as help people understand the phases of team development.

Improvement strategies overlap frequently - during Kaizen training much effort was placed on making things visual- you can see the results in the video where visual controls such as scoreboards for production goals, shadow boards for tool, and signs were used in many places to improve communications between and within shifts. Instead of relying on the untimely inaccurate computer data base, all could see and understand up to date performance metrics on the score boards or when a tool was missing from the shadow board, or the use of kanban to shown when to move parts. The simple yet effective visuals provide a great source for feedback to autonomous teams helping them to understand how they were doing and make corrections if production or quality started a negative trend.

Networking and Alliance building were not address in this improvement effort, although steps were in the works to work with sister companies and suppliers.

HPT Model: Evaluation Phase



Evaluation

"To illuminate and improve the organization"

On many of the Performance Improvement Projects that I have worked on, evaluation always proves to be the hardest section to wrap up. It is also proving to be one of the harder sections to write about in this report. All too often, we tend to move on to the next project without formally evaluating the results and as a result loose the opportunity for continuous improvement of the improvement process. I sense writing this paper will spur me on to revisit SURGICAL TOOL MFG, to perform a meta evaluation to evaluate formative, summative and confirmative

processes we used and to gain insight. It has been almost 5 years since my involvement in the Improvement Project ended. Many of the peopled who worked with me may have moved onto new adventures and jobs. This would be a great opportunity to see if the performance improvement interventions stuck or if behaviors and outcomes reverted to a previous state.

Formative Evaluation Phase

We used the formative evaluation phase as a diagnostic tool, helping us to define clearly the performance improvement efforts. Picking the right focus is so important. "Doing the right things, then doing the right things right". The PT, coach, or manufacturing engineer, can help guide top leaders to decide what to focus on, setting the boundaries and establishing the purpose, goals, objectives and scope of the evaluation. Many companies – Toyota as a stellar example, uses formative analysis as part of development process continuously. This phase continued through selection and design interventions and into implementation as we moved from focused factory to the next focused factory.

Performance Analysis- Solving complex problems requires an enterprise wide view with internal and extern scans, understanding our strengths, weaknesses, opportunities and threats. Too many times, we tend to take a myopic focus. Many say "let people closest to the work make the decisions on what to work on"- at this point I need to disagree. Top leaders with a broad vision inside and outside the company need to choose **"what"** to focus improvement efforts on, lest we choose improvement efforts that are not linked to bottom line results. Once leaders set direction, employees closest to the work should have autonomy in making the **"how"** decisions of improvement that lead to the desired outcomes.

Beginning with performance analysis, we defined the current state employing several evaluation means, tradition and alternative evaluation methods. Expert reviews, brain storming sessions, small group team evaluations and RIP teams (rapid improvement process) developed rapid prototyping to design new and more efficient workflows. Top leaders and financial experts used tools such as transformation planner to link performance with bottom line outcomes. Our kaizen teams used process maps to identify flows of material and information and waste at each step of the process. Floor layouts made waste visual, showing time and distance needed to move materials and information. Scoreboards show up to date production activities and goals.

Cause Analysis- With a clear understanding of what the market and customers demanded, top leaders at SURGICAL TOOL MANUFACTURIING understood plainly the root cause of the problems. SURGICAL TOOL MANUFACTURIING was losing business due to long lead times and quality defects. For profitable growth, the company would need to produce and deliver high quality much faster. Performance analysis showed potential to eliminate huge amounts of non-value adding activity and time that would lead to short lead times and high quality products.

Selection/Design of Interventions – The performance improvement Interventions employed fell under the umbrella of LEAN interventions. We started with the basics- the plant had to be clean and organized (including information). Financial systems were organized to expose problems and profits by product line. Team members were taught to understand what waste is and what adds value, and then take steps to standardize each process in an effort to expose more variation and non-value adding time and activity. We employed tools to help improve communication such as visual controls, scoreboards and kanban systems. We developed

team charters to establish roles, how to resolve conflict and rules of conduct that encourage respect for team members. We used an action learning approach and a process coach to assist fast paced on the floor, learn by doing, learning.

Summative Evaluation Phase

Immediate Reaction- The immediate reaction on the floor proved negative- "we've done that, tried that, it won't work". (Note: I sense we missed employing a very important tool – benchmarking. Had our teams had the opportunity to visit other companies that were already using lean manufacturing they could see others doing what they thought to be the unbelievable, and they would have seen and believed more quickly - LEAN Process and Kaizen could work for them.) For instance, changeovers could be quick- less than a minute. Making 2 pieces at a time can be effective (even if I have a machine that can spit out thousand of part an hour). Lead times can be cut from 12 weeks to 2 days. Quality can be at 99.5%. How teams see the future affects the future-, seeing is believing. Benchmarking is an effective tool we need to use next time.

Confirmative Evaluation Phase

Six months after the performance improvement intervention started, I videotaped one-on-one interviews with many of the key players in the intervention effort. This confirmative evaluation helped to explain and confirm the value of the performance intervention of the SURGICAL TOOL MANUFACTURIING LEAN initiative. The video can be found in the reference section and on line at

http://www.jboyleengineering.com/videos/PYTD/PE%20Performance%20Analysis%201/PE%20Performance%20Analysis%201_controller.swf

Conclusion

Five years have lapsed since I last worked with SURGICAL TOOL MANUFACTURING. During a 7 month, continuous improvement effort we employed each phase of the Human Performance Technology Model based on Gilberts Behavior Engineering Model (BEM). During the project we used Performance Analysis, Cause Analysis, Intervention Selection, Intervention Implementation and Evaluation, but one phase is missing, the Meta Evaluation. The Meta Evaluation phase requires time to evaluate the improvement processes, products and outcomes to examine what happened and why because of the performance improvement intervention efforts. Perhaps this paper will spur me on to complete the final phase- did the intended behaviors and performance improvements stick over time.

References

Gilbert, T. (1978) . *Human Competence - Engineering Worthy Performance.* New York: McGraw-Hill, Inc.

Linne, L. (2009) *Make the Noise Go Away.* Bloomington, IN: IUniverse

Rothwell, William J, (2007) *Human Performance Improvement.* Burlington MA: Elsevier Inc.

Van Tiem, D., Mosseley J., , Dessinger J, *Fundamentals of Performance Technology: A Guide to Improving People, process, and Performance.* (2004) International Society for performance Improvement: Silver Spring, MD

Van Tiem, D., Mosseley J., , Dessinger J, *Performance Improvement Interventions.* (2001) International Society for performance Improvement: Silver Spring, MD

Boyle, J. Jboyle Engineering, LLC. (2012) Video photos and structured interviews showing, Performance Analysis, Cause Analysis, Intervention Selection, Intervention Implementation, and Evaluation
http://www.jboyleengineering.com/videos/PYTD/PE%20Performance%20Analysis%201/PE%20Performance%20Analysis%201_controller.swf

Appendix

Improvement Opportunity Calculator

Indicator	Current State Inputs
Annual Revenue ($)	$18,000,000
Direct Materials ($)	$8,730,000
Direct Labor ($)	$4,284,000
Manufacturing Overhead ($)	$1,285,200
Beginning - Ending Inventory($)	$100,000
Cost of Goods Manufactured	$14,399,200
Average Inventory ($)	$14,850,000
Utilities ($)	$266,400
Outside Services	$ -
Scrap and rework ($)	$579,150
Premium Freight ($)	$9,360
Average Receivables ($)	$2,835,000
On-Time Deliveries %	80.00%
Machine Hours Avail per year	4160
Machine Hrs Running per year	2496
Schedule Bumping %	15.00%
Annual Employee Turnover %	23.00%
Average Work week in Hours	48.00
# of Hourly Employees	86
# of Salary Employees	31
Average Hourly Pay ($)	$21.06

Definitions

Note: items in yellow you input data

What drives our economic engine? Use this tool to develop what if scenarios that will help you make decisions investing in improvement projects. These definitions and video tutorial will help.

Direct materials: The cost of materials directly used in the production of specific goods - raw materials, parts, and subcontracted services like heat treating, ect.)

Cost of Goods Manufactured: Can be found on the company's income statement. It does not include "Sales, General and Administrative Expenses" (SG&A). COGS is the total cost of acquiring raw materials and turning them into finished goods. Has four main components 1. direct labor, 2. direct materials, 3. manufacturing overhead, and 4. Beginning inventory less ending inventory.

Beginning – Ending Inventory: An adjustment for change in inventory levels during the period.

Scrap and Rework: waste due to errors , that should not arise under efficient operating conditions. Includes material, parts, labor and outside processing to scrap or make salable. Don't include design scrap or offal.

Machine Hours Available: Hours manned- (# of shifts x # of hours per shift/week x # of weeks) use an average for regular use machines. Apply to bottleneck machines.

Machine Hours Running: Total number of hours that a machine is actually running. Can estimate as a percent of machine hours available.

Annual Employee Turnover: People who leave that need to be replaced. (# of employees leaving / Avg # of employees)

Schedule Bumping: % of time scheduled orders were stopped to allow for rush orders.

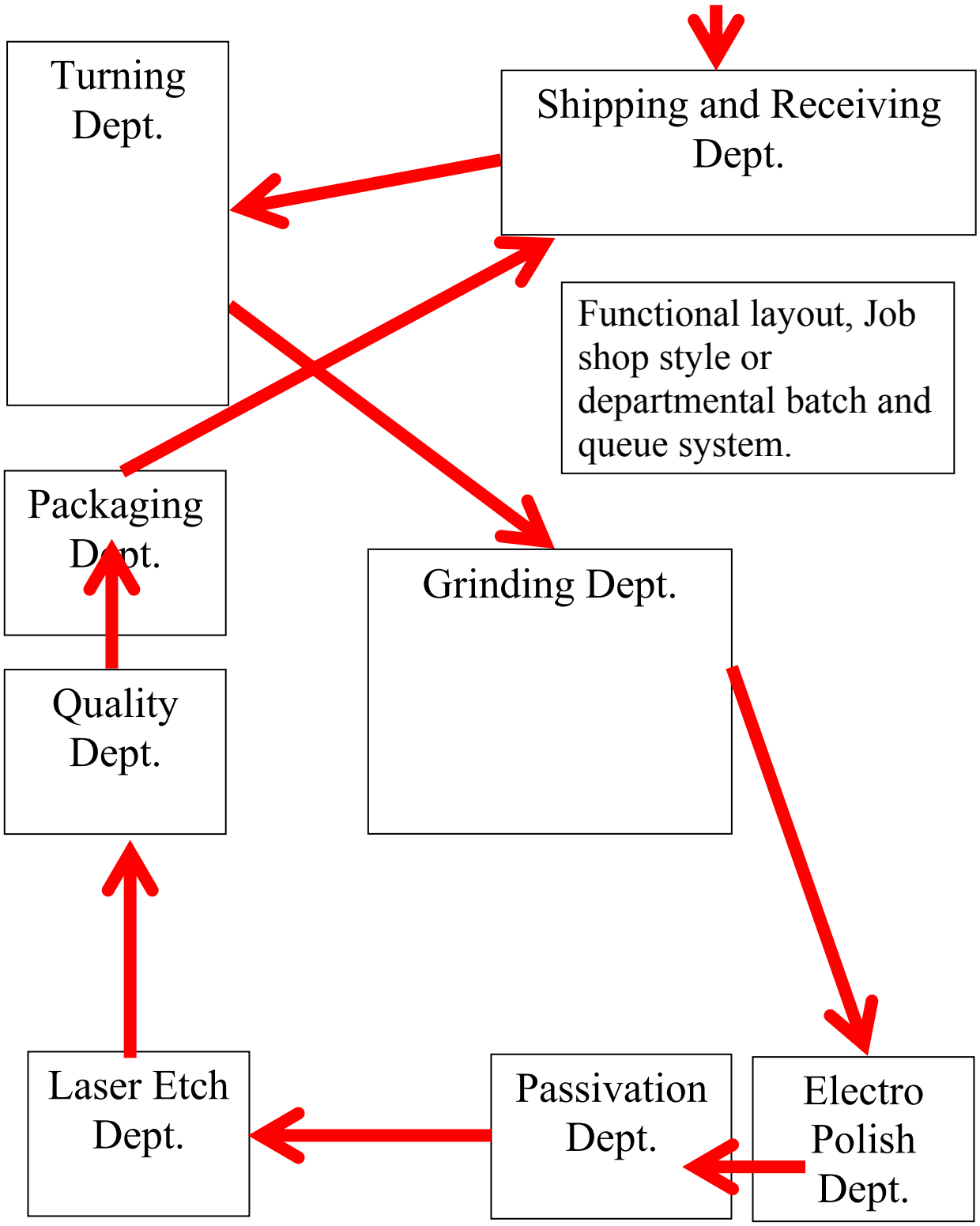
Average Hourly Pay: the pay rate and costs of employment such as benefits, taxes, retirement etc. (Direct Labor and Indirect labor cost $/# FTE) (1/2080 hours) or add % to known average hourly pay for benefits burden.

Calculated Metrics		
Cost of goods Manufactured	$14,399,200	brown = outputs, calculated cells
Gross Profit and Gross Margin %	$3,600,800	
Inventory Turns	0.97	20.0%
Value-Added	$9,003,600	
Scrap and rework	4.02%	
Days receivables	57.49	
Available Hrs % Year	47.62%	
Run Hours % Available	60.00%	
otal hours per week for Hourly Employees	4,128	
Hours for Salary Employees	1,240	
FTE	134.20	
Value Added per FTE	$67,091	Total Hrs (H&S)

Direct Labor: The cost of labor used directly in the manufacture of goods as opposed to that used for support functions such as maintenance.
Manufacturing Overhead: includes all costs needed to produce goods, but can't be tied to specific goods themselves. This includes: indirect labor (machine maintenance, janitorial, inspection, material handling, factory supervisors, engineering/design staff), general factory supplies, depreciation of plant and equipment, property taxes, factory insurance and factory heat and light.
Gross Profit = Revenue − Cost of Goods Sold
Gross Margin Percentage = (Revenue-Cost of Goods Sold)/Revenue
Value added: subtract the sum of the cost of materials, supplies, containers, fuels, purchased electricity, and contract work from the total value of products.
Inventory turn: Number of times inventory is replenished in a year; generally calculated by dividing the average inventory level (or current inventory level) into the annual inventory usage (annual cost of goods sold).
FTE: Full time equivalent = salaried employees plus the number of hourly employees as if working on a 40 hour work week,

erformance Indicator	urrent State	Improved Future State	Annual Benefit	nversion To Cash
Days Receivables (Days)	57.49	35.00	$99,808	$1,108,973
Employee Turnover %	23%	10.00%	$105,815	
Inventory Turns	1.0	10.00	$2,279,714	$13,410,080
Machine Uptime Hrs Avail(%)	60.00%	85.00%	$535,500	
On-Time Delivery (%)	80.00%	99.00%	$342,076	
Premium Freight ($)	$9,360	$4,500	$4,860	
Schedule Bumping %	15%	5.00%	$85,680	
Scrap and Rework (%)	4.0%	1.00%	$435,158	
Utilities ($)	$266,400	$250,000	$16,400	
	ed Benefits		3,905,010	14,519,053

ment	urrent State		Future State	
Annual Revenue	18,000,000		18,000,000	
Cost of Goods Manufactured	14,399,200		10,494,190	Annual Benefit
Operating Margin	3,600,800		7,505,810	3,905,010
Operating Margin %	20.0%		41.7%	21.7%
Balance Sheet				One-Time Benefit
Average Inventory	14,850,000		1,439,920	13,410,080
Receivables	2,835,000		1,726,027	1,108,973


Turning Dept.
Shipping and Receiving Dept.
Functional layout, Job shop style or departmental batch and queue system.
Packaging Dept.
Grinding Dept.
Quality Dept.
Laser Etch Dept.
Passivation Dept.
Electro Polish Dept.