My TOC Journey
Why Use TOC to Increase Shareholder Value

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Introduction

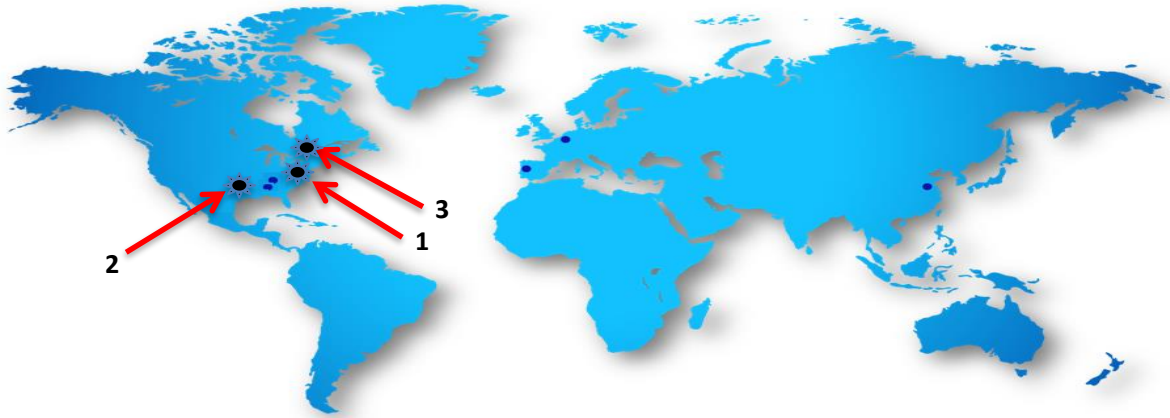
- I have been running organizations for many years including about 50 different factories
- Most of them were in trouble – needed repairs in many different areas
- As with many troubled businesses their systems and process needed repairs
  - Better general legers, finite scheduling systems, etc.
  - All of these were baby steps
  - I even got an APICS certification ☺
  - None of it helped significantly
- About 10 years ago I was introduced to TOC and the CMS Montera team
- I was able to gain an understanding of TOC and its impact on the business functions within the manufacturing operation
- Now we use TOC to get 'large step' improvements
- Let me take you through our TOC implementation journey

Agenda

- Wolverine Tube, Inc. Transformations
  - Wolverine Joining Technologies
  - Wolverine Tube Inc.
  - Great Lakes Copper
- Tecumseh Products Company Implementations
- Applied Process Inc. Implementation
- Journey Summary
- Some Reflections

Wolverine Tube, Inc.

Global Operations



Corporate Headquarters
Decatur, Al

Fabrication Assembly
Ardmore, TN

Metal Joining Alloys
Warwick, RI (1)

Tube Products
Shawnee, OK (2)
Esponsenda, Portugal
Apeldoorn, Netherlands
Shanghai, China
London, Ontario, Canada (3)

WJT Manufacturing

Division of Wolverine Tube, Inc. located in Warwick, RI

- 82K sq. ft. brazing alloy facility
- Approx. 150 employees
- Fully integrated Alloy Mill including:
  - Melting / casting
  - Extrusion hot metal working
  - Wire / rod drawing
  - Strip rolling, slitting, bonding
  - Ring forming and stamping
  - Flux formulation and coating
  - Braze assembly manufacturing
  - Metallurgical laboratory

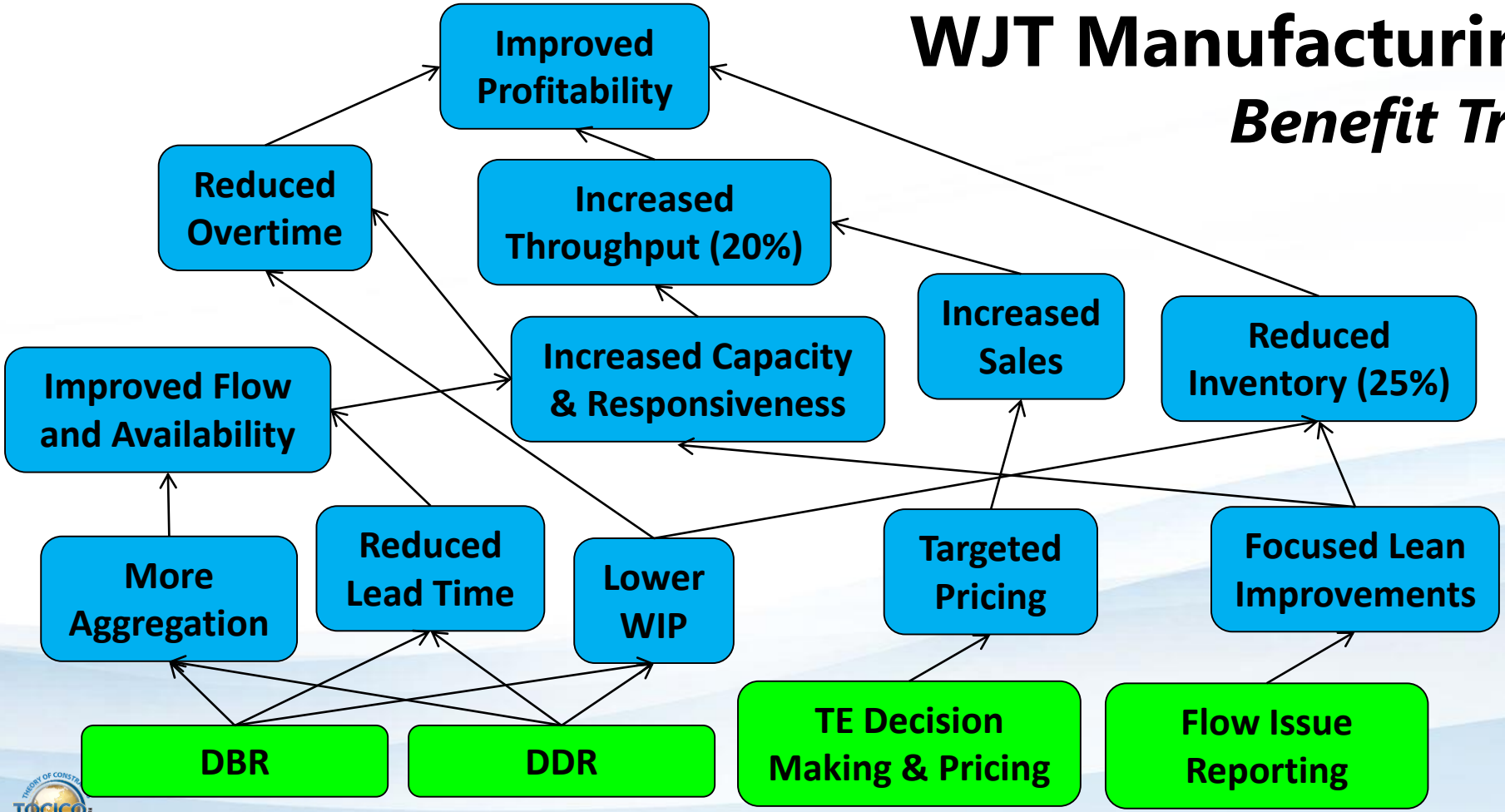
WJT Manufacturing
Performance Challenges

- Finished and Work-in-Process inventory was too high, and not right – primary raw material is silver ($30/oz in 2012)
- Very long and highly variable customer lead times
- Lower than required on-time delivery to Customer Request Date
- Weak understanding of Product Profitability
- Continuous Improvement project prioritization didn't result in significant plant performance improvements

WJT Manufacturing
TOC Implementation Process

- Business Performance Review
- Designed and Implemented Drum-Buffer-Rope (DBR) process for the plant
- Demand Driven Replenishment (DDR) for all Make-to-Stock finished goods and multiple sub-assemblies
- Started Throughput Economics (TE) based decision making process
- Supported by CMS RoadRunner software

WJT Manufacturing
Benefit Tree

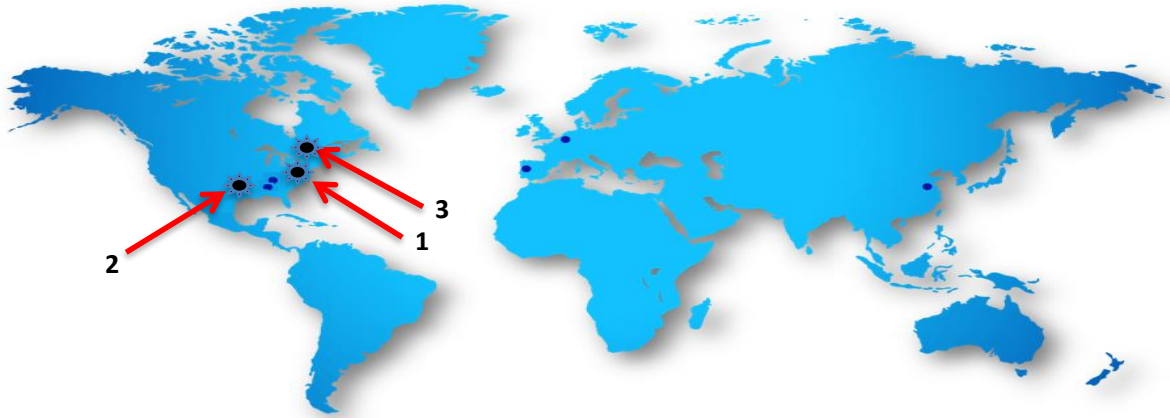


WJT Manufacturing
Implementation Results

- Significant inventory reduction including WIP
- CMS RoadRunner provided excellent visibility of shop floor priorities
- TOC implementation increased sale price
- Company was sold by the time implementation was complete

Wolverine Tube, Inc.

Global Operations



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WTI Manufacturing

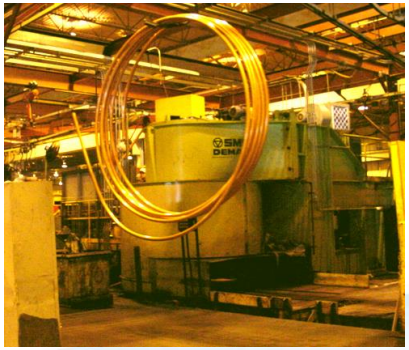
- Shawnee, OK
- Built in 1974 by WLV
- 50 Acre Site
- 325,000 Square Feet
- 530 Employees

WTI Manufacturing
Performance Challenges

- High working capital investment
- Too long customer lead times
- Poor customer service / responsiveness
- Not enough plant capacity - seasonal
- Too much Work in Process inventory
- Insufficient Overall Equipment Effectiveness
- Poor understanding of Product Profitability and plant Continuous Improvement requirements

WTI Manufacturing
TOC Implementation

- Business Performance Review
- Designed and Implemented Drum-Buffer-Rope process for the plant
  - 48 drums in technical side of the plant
- Demand Driven Replenishment for all Make-to-Stock Finished Goods
- Throughput Economics based decision making process
  - Stream profitability – industrial vs. technical
- Designed Flow Issue Reporting based Continuous Improvement process
- Supported by CMS RoadRunner software

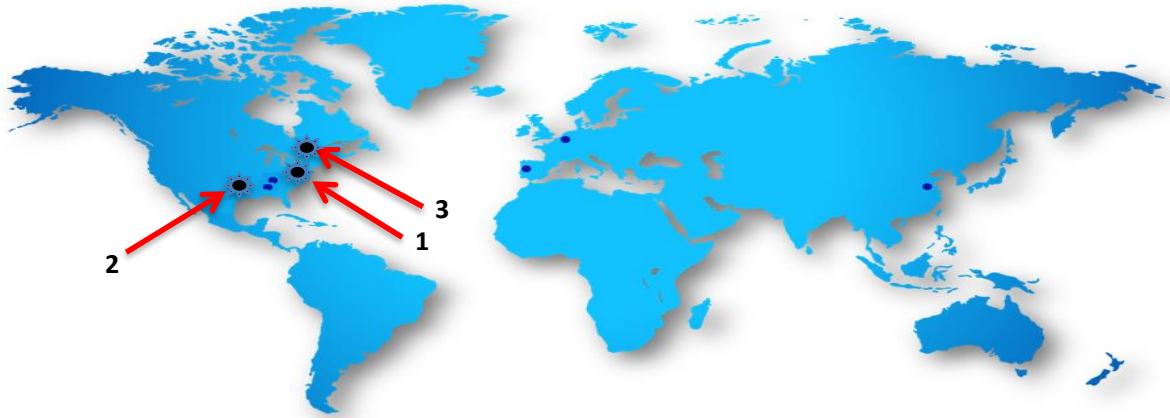


WTI Manufacturing
Implementation Results

- Significant Throughput Increase
- Overall T/OE increase – also used to understand stream (technical vs industrial) profitability
- On-time delivery improvement
- Company split into two businesses and successfully sold

Wolverine Tube, Inc.

Global Operations



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Great Lakes Copper

- TOC Implementation results presented during the TOCICO Conference in 2011 – NY, NY
- Located in the city of London, Ontario, Canada along the 401 Highway corridor for easy access to the great lakes region.
  - between Detroit and Toronto
- Sold to a Canadian VC – changed name to Great Lakes Copper (GLC)

GREAT LAKES COPPER INC.

Great Lakes Copper

- Manufacture seamless copper tube for the plumbing, HVAC, Refrigeration and Natural Gas installation, Medical Gas industries.
- Commercial grade copper tube for various manufacturing industries in both coil form and straight lengths
- As the leading manufacturer of polyethylene coated copper tubing for Natural Gas, Liquefied Petroleum Gas, Fuel Oil, Potable Water and various industrial applications
- A World Class producer of Line set Coils for the residential central air conditioning market

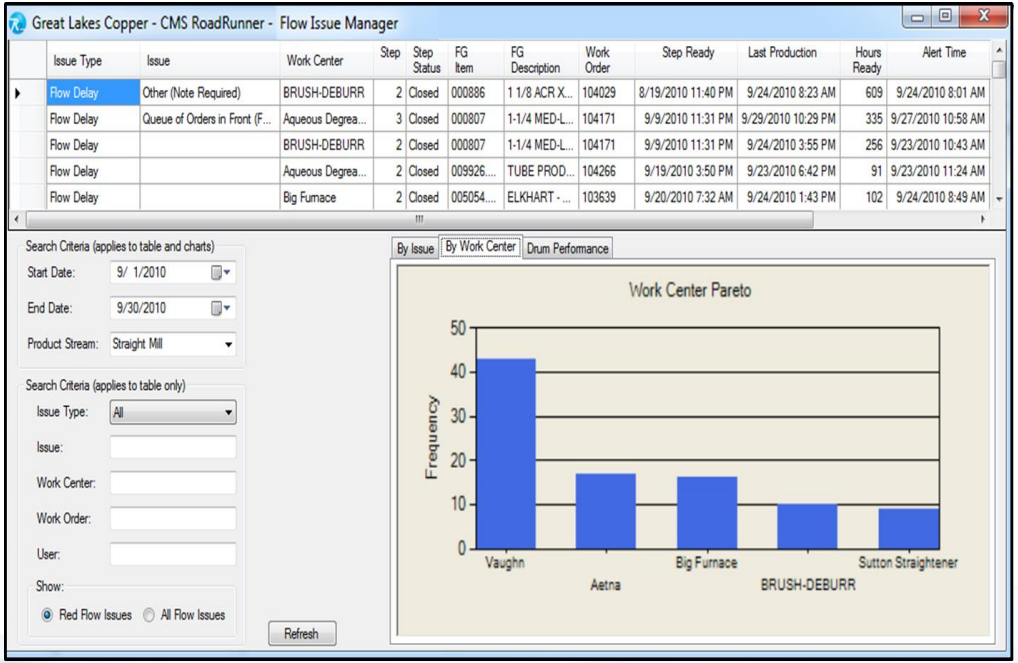
Great Lakes Copper
Performance Challenges

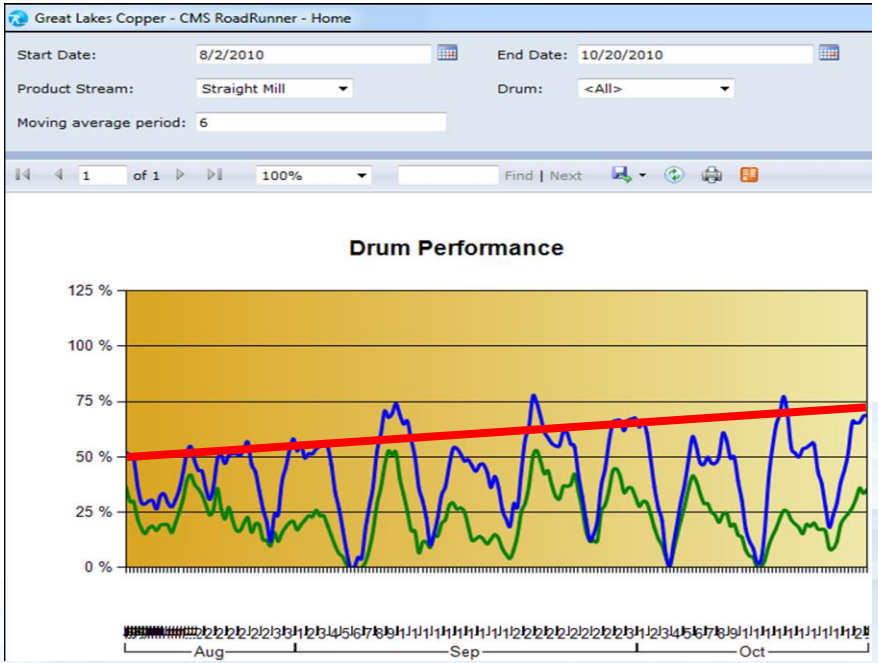
- Excessively long lead times
- Very high inventory levels
- Insufficient customer service performance
- High overtime costs
- Lean improvements throughout but not very focused
- Product costing / profitability understanding based on standard costing approach
- Mainly Make-to-Order environment – highly variable customer demand

Great Lakes Copper
TOC Implementation

- Conducted business performance review in early 2009
- Designed and implemented Drum-Buffer-Rope to manage the plant
- Deployed Demand Driven Replenishment for all Make-to-Stock products
- Implemented Throughput Economics based decision making process – new approach to pricing
- Designed Flow Issue Reporting based Continuous Improvement process
- Installed CMS RoadRunner Manufacturing (Mx) and Business Performance Intelligence (Bx) modules

Great Lakes Copper - *Results*





- Implemented POOGI - Vaughn work centre became a focus for the plant
- Drum Performance screen provided on-going feedback – 50% increase
- Company was sold a couple of years ago at a significant premium

Tecumseh Product Company

Tecumseh Manufactures Compressors in the U.S., Brazil, France and India and Operates Several Assembly Facilities Worldwide

Tecumseh Product Company

- TOC Implementation results presented during the TOCICO Conference in 2016 – Leesburg, VA
- Founded: 1934
- Headquarters: Ann Arbor, MI
- Employees: ~6,000
- Products are sold in approximately 100 countries
- Brands: Tecumseh, L'Unite Hermetique, Masterflux, Silensys, Celseon, Vector & others

Reciprocating Compressors

Rotary Compressors

Scroll Compressors

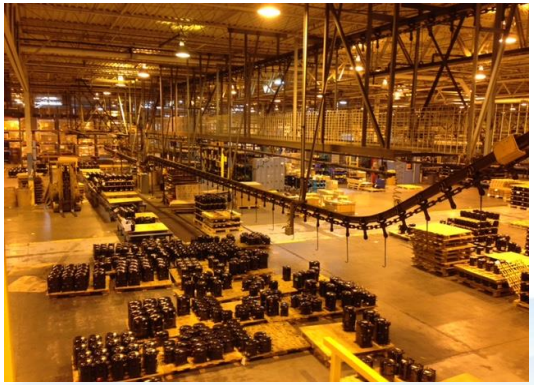
Condensing Units

Tecumseh Product Company
Performance Challenges

- Highly reliant on an inaccurate forecast to drive purchasing and planning decisions resulting in:
  - parts shortages, production schedule changes, expediting, higher freight costs, increased over time and longer lead times
- High and variable inventory levels
- Continuous improvement, engineering and maintenance projects prioritized according to cost reduction opportunities - not flow
- One of the toughest
- No support from my team
- You have to do this or the business will die
- Needed to finally play the CEO card

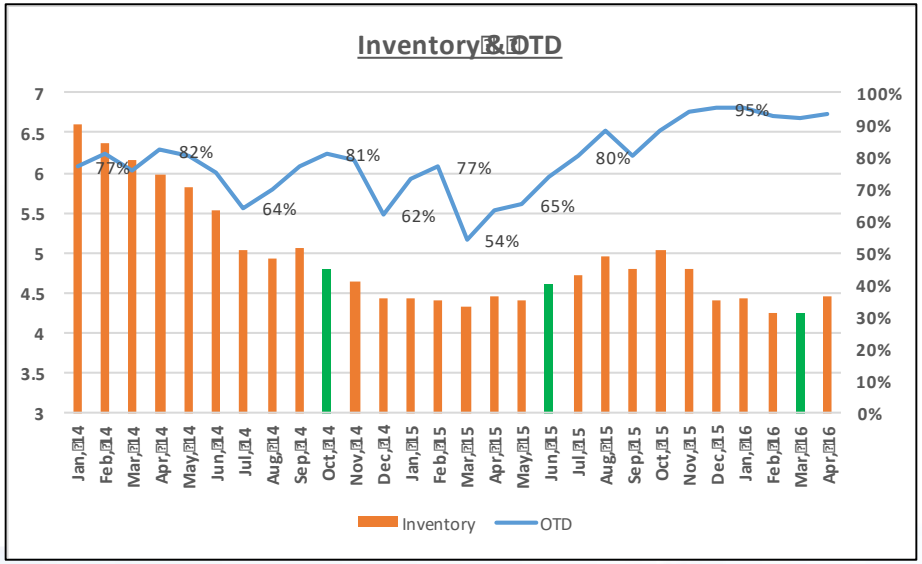
Tecumseh Product Company
TOC Implementation

- Conducted two business performance reviews
- TOC Implemented in the US, Mexico and Brazilian facilities
- Designed and implemented Drum-Buffer-Rope in all plants
- Deployed Demand Driven Replenishment for all Make-to-Stock finished goods, Raw Materials and Sub-Assemblies
- Implemented Throughput Economics based decision making process to enable TE based pricing (in the USA)
- Enabled Flow Issue Reporting based Continuous Improvement process
- Installed CMS RoadRunner to support implementations
  - Including the latest Pricing Evaluation Module (PEM)
- Tecumseh, a publicly traded company, was taken private in the middle of the implementation and sold to a private equity firm at a premium



Tecumseh Product Company

Implementation Results



- Brazil - Inventory Days on Hand (IDOH) dropped by approx. 28% - no more obsolete inventory
- Tupelo, MS - 12% inventory reduction (6 month after implementation – target 30%)
  - OTD Increase to 95% at the same time
- T/OE productivity - very stable despite significant market challenges

Applied Process

OUR FACILITIES

Applied Process Inc. – Livonia, MI USA

AP Westshore Inc. – Oshkosh, WI USA

AP Fort Smith - Fort Smith, AR USA

Applied Process

- Applied Process is the world-wide leader in Austempering (salt quench) technology
- Our foundry and heat treat metallurgical bench strength is un-matched in the industry
  - Dedicated R&D center, metallurgists / materials engineers
- Our plants are state-of-the-science, clean, safe, efficient
  - Both are ISO 9001-2008 certified.
  - Livonia is NADCAP certified (Aerospace)
- The majority of our business is derived from engineering conversions
  - Our engineers assist our customers in the development of the optimal material/process combination

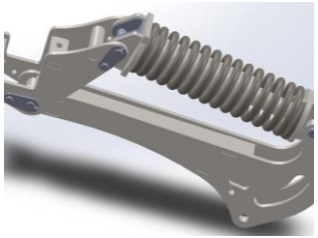
Applied Process *Performance Challenges*

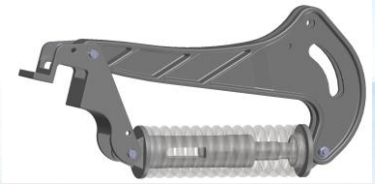
- Effective utilization of key pieces of equipment was too low
- Inconsistent operational performance between two plants
- Long lead times in busy season
- No Finished Goods inventory to protect plants from customer order variability
- Plant labor availability
- Continuous improvement process based on perceived cost savings instead of flow improvements

Applied Process

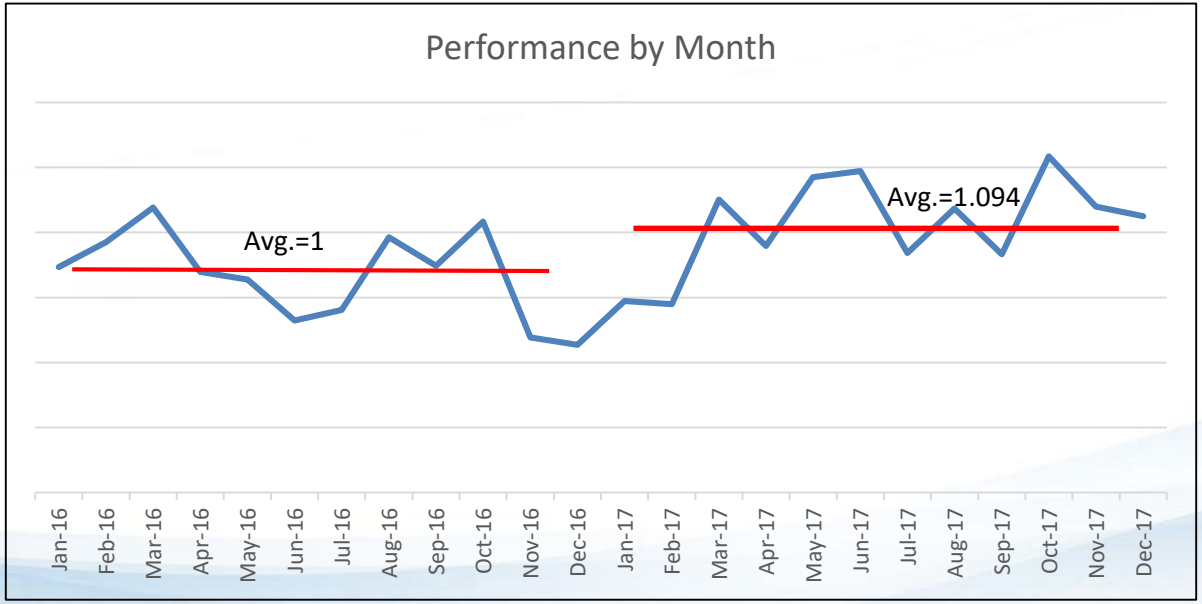
TOC Implementation

- Conducted business performance review
- Designed and implemented Drum-Buffer-Rope in two plants – Fort Smith this summer
- Implementing (brand new for AP) Demand Driven Replenishment for all possible Make-to-Stock products
- Implemented Throughput Economics based decision making process
- Enabled Flow Issue Reporting based Continuous Improvement process with new Hours Lost Measures
- Installed CMS RoadRunner software to support and drive all implementations
  - Includes highly detail scheduling algorithms and 'coupled drums'





Applied Process
Implementation Results



Average monthly year to year shipments increased by 9.4%

- **Before the end of the implementation!**
  - 6% over the first 6 months
  - 13.2% over the second 6 months
  - 15% increase in EBITDA

- Livonia, MI operation shipped 29% more $T in the second half of the year (during implementation)

T/OE productivity – increased significantly

Journey Summary

PERFORMANCE CHALLENGE	WJT	WTI	GLC	TPC	AP
Reliance on inaccurate forecast	X		X	X	
Long lead times	X	X	X	X	X
High inventories	X		X	X	
Poor customer responsiveness	X	X	X	X	
Low asset utilization		X		X	X
High overtime costs	X		X	X	
Not enough capacity		X	X		X
Poor understanding of product profitability	X	X	X	X	
Unfocused CI / Lean process	X		X	X	X
Inadequate labor availability		X			X
Highly variable customer demand		X		X	X
Mainly MTO / Not enough MTS	X		X	X	X

- Diverse set of issues
- Very similar set of TOC applications implemented
- Significant impact on company performance and bottom line results
- 4 out of 5 companies successfully sold

Theory of Constraints became my "weapon of choice" to complete large business transformations and maximize shareholder value

Some of my Reflection

- TOC and CMS RoadRunner software together significantly increase velocity and flow through your business
- The solutions are not always as simple as ‘they say’ – people have to get into the details and work hard
- Doing it without the consulting help wouldn’t be possible – takes too long
- Couldn’t get there without the CMS RoadRunner software
- Use the CEO card when needed
- It always takes more months than expected
- Work with your consultants over dinners ☺

Presenter Bios

- **Harold Karp** is the CEO of Applied Process, Inc. a company who specializes in the Austempering heat treatment of ferrous materials
- Prior to Applied Process Harold was the President & Chief Executive Officer and Board Director at Tecumseh Products Company a leading global manufacturer of compressors
- He was also a President and COO of Wolverine Tube, Inc. ($1.2B)
- Earlier, Harold had a career with Alcatel North America, Inc., where he advanced through many business functions ultimately being promoted to VP/General Manager
- Harold received his MBA and Management degree from Bellarmine University, and his B.S. in Accounting from University of Kentucky. He is a Certified Management Accountant (CMA), and Certified Production and Inventory Manager APICS (CPIM)
- **Jack Warchalowski** is the President of CMS Montera.
- Prior to CMS, Jack was the head of operations for the High Tech manufacturer, Ernst & Young management consultant, and a project engineer with Babcock & Wilcox.
- Jack is a Certified Management Consultant and a Professional Engineer registered in Ontario. He holds an MBA degree from the Wilfrid Laurier University and a Bachelor of Applied Science in Mechanical Engineering from the University of Waterloo in Waterloo, Ontario. In addition, Jack is certified by the TOCICO in all aspects of TOC.