MFRI, Inc. – The Perma-Pipe DDMRP Journey

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Perma-Pipe: A leading manufacturer of pre-insulated piping systems, supplying a broad customer base, including industrial, chemical and petroleum producers, airports, governmental agencies, housing projects, universities, and prisons.

Thermal Care: A leading manufacturer of energy efficient liquid chillers and plant circulating systems used to remove heat from industrial processes for customers around the globe.

Midwesco Mechanical: Providing energy efficient heating, ventilation, and air conditioning (HVAC) systems for large commercial, industrial, and institutional projects.

Midwesco Filter: Helping industry protect its equipment and the environment through the manufacture and supply of air filtration elements for a worldwide customer base.
Perma-Pipe Products

- POLYTERM®: A fiberglass jacketed, spray-applied system.
- XTRU-THERM®: XTRU-THERM® is our "State of the Art" product.
- ESCON-A® FERRO-SHIELD™: ESCON-A® FERRO-SHIELD™ is the original product.
- MULTI-THERM® 500: MULTI-THERM® 500 is the best pre-bonded product.
- MULTI-THERM® 750 SUPREME: The MULTI-THERM® 750 SUPREME is the best pre-... read more
- TERRA-GARD™: TERRA-GARD™ is an economic choice for... read more
- CALVA-GARD®: CALVA-GARD® is the "Ultimate Corrosion"... read more
- ULTRA-THERM®: ULTRA-THERM® is the next generation of... read more

Perma-Pipe Product Installation
Perma-Pipe Project EPCOT

The Perma-Pipe Supply Chain

Order Entry → Project Submittal → Customer Approval

Plant Engineering → Purchasing → Fabrication → Shipping
A Solution 1982?

The Fundamental Manufacturing Equation

What are we going to make?

What does it take to make it?

What have we got?

What do we have to get (and when)?
Perma-Pipe Project Sample

Perma-Pipe Project Sample (continued)
Perma-Pipe Project Sample (continued)

MRP Assumptions

- File data are accurate and complete
- Lead times are known
- Every inventory item goes into and out of stock
- Full allocation
- Discrete Components
- Order Independence
Requirements for MRP

- Master Schedule stated in BOM terms
- Unique Item Number
- A BOM exists at planning time
- Inventory Records for all items

The Perma-Pipe ETO/MTO Environment

- Highly Seasonal (April-October)
- Wide Range of Order Size
- No defined end items
- Truck shipping limits size of pieces and how many pieces per shipment
- When shipping more that one truck, trucks must arrive in sequence
- Purchase based on customer order
- Final material requirements not known until plant engineering complete
Square Peg - Round Hole

What did we do?

• Wrote own software.
  • 4, 8, 15, 16, 23, 42
  • 3, 32, 5110, 5120, 38, 400, LAN
  • MFRI WIP System
  • Capacity Planning by model
  • Schedule by total man hours available
  • Implemented MAPICS Inventory Module – Inventory Record Accuracy
• And that was the way things would stay for a long time
Next Stop 2004

- MFRI Companies Midwesco Filter Resources, Thermal Care, TDC Filter Manufacturing implement TOC under the guidance of Constraints Management Group.
- Perma-Pipe implements Visual Manufacturing replacing home grown WIP System

2013 Demand Driven Comes to Perma-Pipe

- New Plant Manager
- January 2013 Perma-Pipe engages Constraints Management Group to Implement a Demand Driven Operating System

And the Demand Driven Journey Finally Begins
Step 1 – Learn to Think Systemically

Understand The Dilemmas
Blocking System Flow

Starts With Logical Diagrams of Each Area’s Fire-fighting Conflicts
Summary of Firefighting Actions in Current Reality

- Spend extra time for verification and root cause analysis
- Micromanage variances at the project level after the fact
- Constantly move people and materials
- Authorize OT, change schedule, negotiate new due dates (constantly deviate or massage schedule)
- Constantly adjust transactions to match actual
- Expedite and/or order additional material
- Stop materials and labor in process
- Scramble to accommodate changes to released orders
- Drop things and react to immediate issues
- Constantly review large projects against specification

Summary of Actions to Manage The Projects At A Company/System Level

- Spend less time on verification and root cause analysis
- Automated and consistent controls across all company projects during the project
- Keep people and materials on task and in place
- Do not constantly deviate and massage the schedule
- Automated inventory and project control system
- Do not expedite and/or order additional material
- Do not stop materials and labor in process
- Limit changes to released orders
- Stay on task
- Spend little time on project review - more time on selling new
Unresolved Company’s Dilemma Effects Every Manager

- Protect each project’s deliverables (internal and external)
- Manage the company through each project (focus on the project)
- Protect limited resources
- Manage the projects at a company/system level (focus on the system)
- Firefighting spirals management induced variation from the actions and reactions throughout the supply chain.

A Good Solution Must Protect Both Necessary Conditions

- The Objective
  - Maximize Company profit potential
  - Protect each project’s deliverables (internal and external)
- Necessary condition
  - Protect total system output and quality
- Solution
We Want to Move Here Because

- Protect total system output and quality
- Manage the projects at a company/system level (focus on the system)

1. Short term focus on a project does not consider impacts across projects
2. It may be easier to manage at a systemic level
3. More predictable company results
4. We have to look across all projects to get a valid schedule and capacity perspective
5. We might understand our economic drivers/costs better
6. We might see more quality improvement opportunities
7. We can utilize common materials across jobs
8. We can schedule across jobs better (reduce set-ups on critical resources)
9. Total company profit can be maximized through a systemic approach
10. We may have opportunities to buy for the system rather buy for a project
11. We could combine/synchronize loads for shipping - currently it can take up to 14 days to load a truck

We Are Stuck Managing In this Mode Because...

- Protect each project’s deliverables (internal and external)
- Manage the company through each project (focus on the project)

1. Every project has some unique qualities
2. Cookie cutter approaches won’t work here
3. Only existing metric that we have (project metric)
4. If we are successful at each project we will be successful as a company
5. Lots of unknowns with larger projects (can’t plan all the variation in advance)
6. We don’t produce standard product
7. Meet individual customer requirements
8. Controlling at the project level gets the project done faster
9. Easy to understand the profit impact of each decision on the project
10. Understand in advance what the variances will be
11. This is the only way we know
The Conflict Gets Worse When We Jump Back and Forth

1. We have seasonally (bigger conflict in summer)
2. We cost our projects on a job by job basis
3. Our system metrics don’t tell us how to act only what happened
4. We can’t measure company profitability until the end of the month
5. Projects have less commonality between them
6. Different sites see and are responsible for different things
7. Cash is sensitive
8. The market is more price sensitive
9. We make special project commitments that overrides schedule
10. Limited view of capacity
11. Space limitations limit capacity (too many large items at once)
12. Customers make changes after job is on the floor
13. Reps believe they can hold schedule with incomplete specs

Manage the company through each project (focus on project)

Manage the projects at a company/system level (focus on system)
Root Cause Assessment

Our “System” and measures force us to manage the company through each project.

What we really want to do is manage all of the projects at a Company/System level.

The Solution Direction

Manage And Measure The Projects At A Company/System Level

Create a system that visibly connects the task due dates, status and priorities in the project build schedules to the rest of the supply chain for determining and agreeing on work priorities.
Manage Flow With Relevant Information

Visibility to the flow of relevant information and materials across the supply chain ensures system coherence and speeds flow:

- Aligns priorities, schedules and execution
- Speeds conflict resolution
- Defines when and where to act
- People will self-organize to solve/act

You can’t measure what you can’t see!

The Effects of These Organizational Conflicts

QUESTION: What is the impact of such Organizational conflicts on the Effectiveness and Efficiency of the Organization as a Whole?

Many times we get stuck between a “Rock and Hard Place”...

How do we deal with such Dilemmas?

We compromise. It’s called a compromise because we end up cutting short on one or both of the Necessary Conditions for the Overall Objective.

This tends to produce an “oscillating” effect between the two sides – a continuous set of trade-offs.

This Oscillation between 2 sets of symptoms has devastating effects on Overall System Performance.

Symptoms continue to persist because we fail to end the compromise and conflict.
Sources of Variability

Defining Flow at Perma-Pipe

• Where we started
  • 10-12 Trailers sitting for up to 2 weeks. All shipments scheduled on Friday.
Step 2 - Become Demand Driven

2. Design the Demand Driven Operating Model.
3. Protect Decoupling and Control Points from variation.
4. Bring the model to the organization.

The Demand Driven Adaptive System Embraces Flow

Flow: the rate at which a system converts information and material to product required by a customer.
Cash velocity: the rate of net cash generation; sales dollars minus truly variable costs (aka contribution margin) minus period operating expense.
Net profit/investment: the equation for ROI

Visibility: defined as relevant information for decision making.
Variability: defined as the summation of the differences between our plan and what happens.
High Level Demand Driven Operating Model

Actual task times approximately 2 weeks each for design and engineering and 2 to 3 weeks for manufacturing but....

The Coupled Lead Time 3 to 5 months

Understand the System

Nonlinear systems can only be understood by mapping the dependencies and interconnections

Engineer to Order

Actual Coupled Lead Time 3 to 5 months
Decoupling Points = Independent Planning Horizons

- A place to disconnect the events happening on one side from being directly connected to the events happening on the other side.

- They delineate the boundaries of at least two independently planned and managed horizons.

- They are commonly associated with stock positions.

  - They can also be strategic buffers of time between subsystems.

Benefits of Decoupling Lead Times

The customer experiences a shorter and reliable lead time.

Decoupling implications for planning and scheduling:

- The planning lead time shrinks.
- The forecast error over the planning lead time also shrinks.
Strategic Control Points Simplify Managing Complex Systems

Places to impose order and visibility for system alignment

Choosing Strategic Control Points

1. **Exit and Entry Points** (shipping and gating) are the boundaries of our effective control. Carefully controlling that entry and exit determines whether delays and gains are generated within or outside of our system.

2. **Common Points** (divergent and convergent) are points where product structures or manufacturing routings either come together (converge) or deviate (diverge). One place controls many things.

3. **Points of Scarce Capacity** (constraints) determine the total system output potential. The slowest resource – the most loaded resource limits/defines the system total capacity.

4. **Points that have Notorious Process Instability**, making it a control point forces the organization to get it under control.
System Output Behavior

The output of a nonlinear system is governed by a few critical points—the “leverage point phenomena.” Strategic control points govern and leverage the system output.

3 Buffer Types Dampen Variation

- **Stock**: All Buffers are strategically stored time.
- **Time**: They all break the effects of variation.
- **Capacity**: 80%
Protect the System Output

The output of nonlinear system is governed by a few critical points – the “leverage point phenomena”

Protect the strategic control points protects and leverages the system output

Scheduling Packet
Niles Engineering Work Order

Making the Model Adaptive
The 10 Zone Buffer Board – Time Stamp the Occurrence

Example: 9 hour buffer

Track & Trend occurrences in the tails of the buffer
Deploy The Operating Model

Demand Driven Model

\[
\Delta \text{Visibility} \to \Delta \text{Variability} \to \text{Core Conflict Area}
\]

Operating the Demand Driven Model (Tactical Time Frame)

\[
\Delta \text{Flow} \to \Delta \text{Cash Velocity} \to \Delta \left( \text{Net Profit\, Investment} \right) \to \Delta \text{ROI}
\]

Plossl’s First Law of Manufacturing

Core Conflict Area

\[
\Delta \text{Visibility} \to \Delta \text{Variability} \to \text{Demand Driven Model Operating the Demand Driven Model (Tactical Time Frame)}
\]

Smart Metrics are:
- Visible and real time relevant information;
- Drive planning & execution to Flow;
- Measure quantity and time;
- Highlight plan status to actual (variation);
- Record and trend the sources of variation;
- Provide focused investment and improvement;

Connect Flow to ROI!

Smart Metrics Operate and Sustain a Demand Driven Model

<table>
<thead>
<tr>
<th>Metric Objectives</th>
<th>The Message</th>
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</thead>
<tbody>
<tr>
<td>System Reliability</td>
<td>Execute to the plan/schedule/market expectation;</td>
</tr>
<tr>
<td>System Stability</td>
<td>Pass on as little variation as possible;</td>
</tr>
<tr>
<td>System Speed/Velocity</td>
<td>Pass the right work on as fast as possible;</td>
</tr>
<tr>
<td>System Improvement &amp; Waste</td>
<td>Point out and prioritize lost ROI opportunities.</td>
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<tr>
<td>(Opportunity $)</td>
<td></td>
</tr>
<tr>
<td>Local Operating Expense</td>
<td>Spend minimization to capture the market opportunity</td>
</tr>
<tr>
<td>Strategic Contribution</td>
<td>Maximize throughput dollar rate and throughput volume according to relevant factors</td>
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</tbody>
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System Visibility To Schedule & Execution Status

The change in “Flow” was easily measured by the rate of change in truck load turns

Production Work Order Packet
Shop Loading

Shop Floor Loading Continued
Defining Flow at Perma-Pipe

• Where we started
  • 10-12 Trailers sitting for up to 2 weeks. All shipments scheduled on Friday.
  • Unreliable ship date

• Where we are
  • Shipments are now scheduled Monday-Friday.
  • Trailers sit for 3-5 days.
  • Significant Reduction in OT
  • Reliable ship date

Step 3 – Deploy Smart Metrics
Questions?

Thank You