

The logo for DOFASCO, featuring the company name in a bold, white, sans-serif font. The text is centered within a blue rectangular box that has thin white horizontal lines above and below the name.

Our product is steel. Our strength is people.

How PI Played a Key Role in Achieving Maximum Equipment Reliability

Presented by: Vlad Djuric
March 11, 2002
OSIsoft Users Conference

Agenda

Dofasco Background & Research

Dofasco Response & Results

New Failure Paradigm

Integration with OSIsoft PI

Case Study

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Case Study

Dofasco Background

- Major North American metal solutions producer
- Annual revenue approximately \$3 Billion
- Produce approximately 4.5 million tons of product per year
- Supply to automotive, manufacturing, construction and packaging customers
- \$5 Billion equipment replacement value

DOFASCO

Our product is steel. Our strength is people.

Dofasco Main Site



DOFASCO

Our product is steel. Our strength is people.

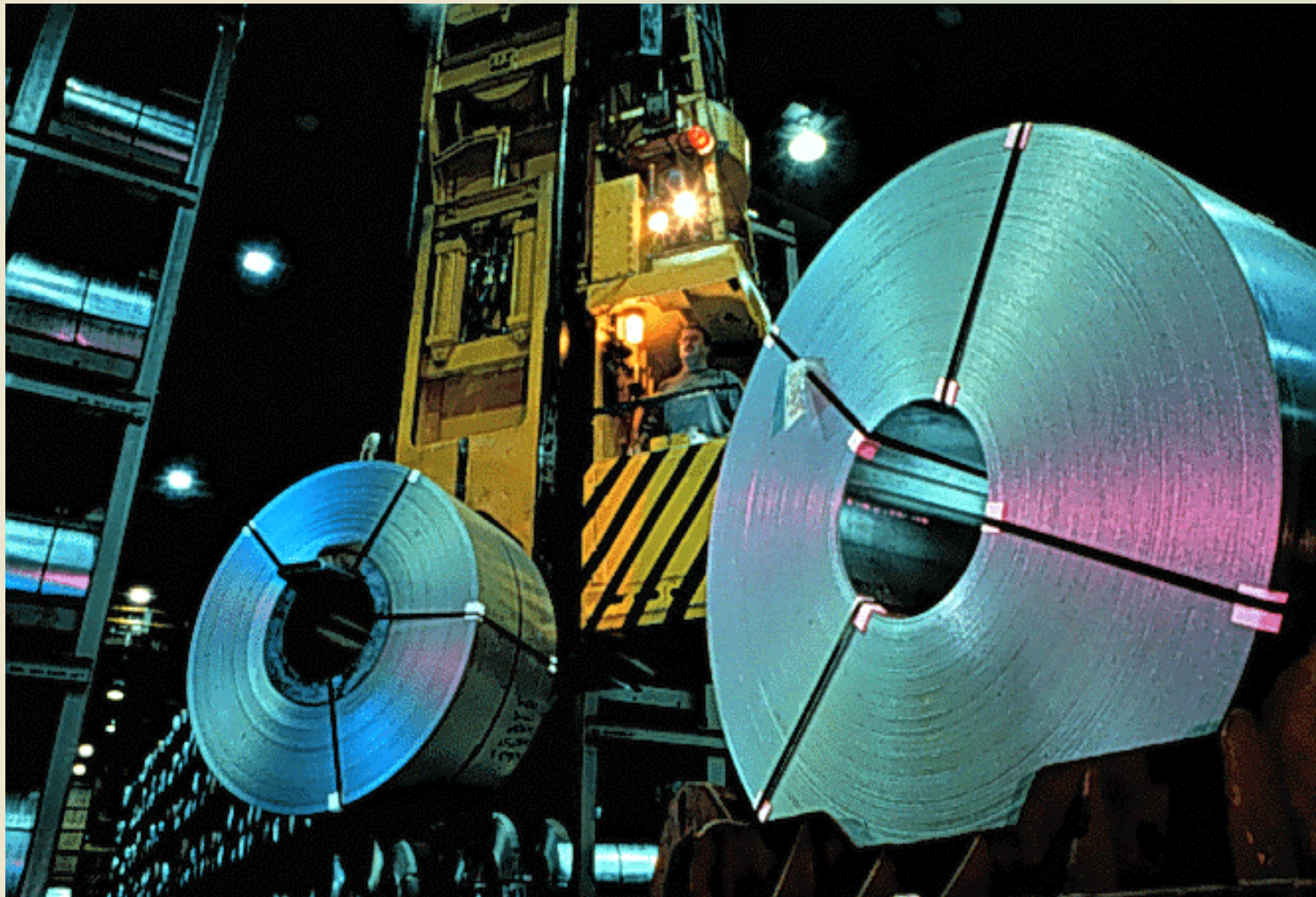
Electric Arc Furnace



DOFASCO

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Central Shipping



Challenges of the late 80's

- Inflation raised costs while market prices dropped
- Globalization
 - High quality Asian imports available at low price
 - Buyer's market
- Profit formula changed:
 - From: $\text{Price} = \text{Cost} + \text{Profit Margin}$
 - To: $\text{Price} - \text{Cost} = \text{Profit Margin}$
- Shareholder value substantially eroded
- Created an urgent need to improve results

Responding to the Changing World of Maintenance

- Dofasco conducted global benchmarking research on:
 - Industry maintenance and reliability practices
 - Predictive maintenance technologies
 - Information systems
 - Reliability methodologies

The Research Findings

- No single country, industry or plant had developed comprehensive best practices
- Pockets of excellence existed
- Reliability improvement efforts were inconsistent and short lived
- Information systems (CMMS, PdM) fell short of user expectations
- Equipment repair cultures were dominant
 - Rather than asset reliability cultures

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Dofasco Response & Results

New Failure Paradigm

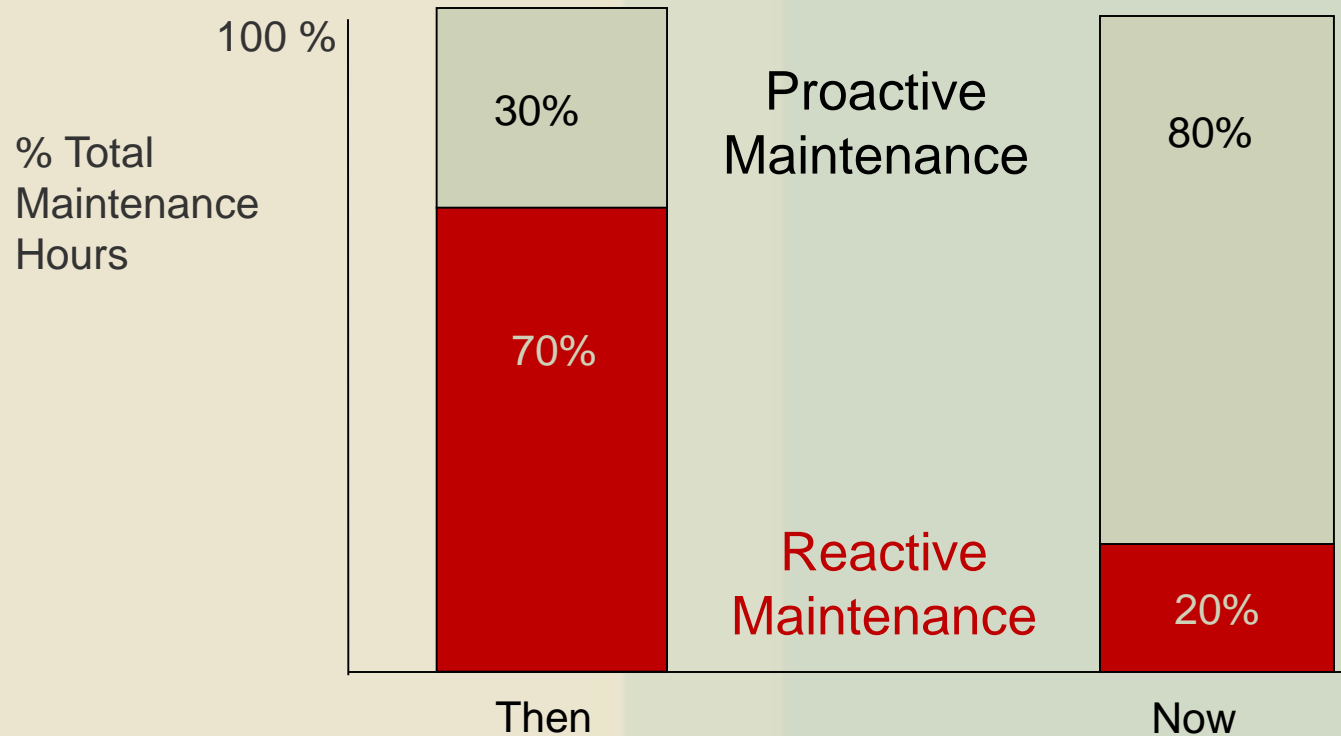
Integration with OSIsoft PI

Case Study

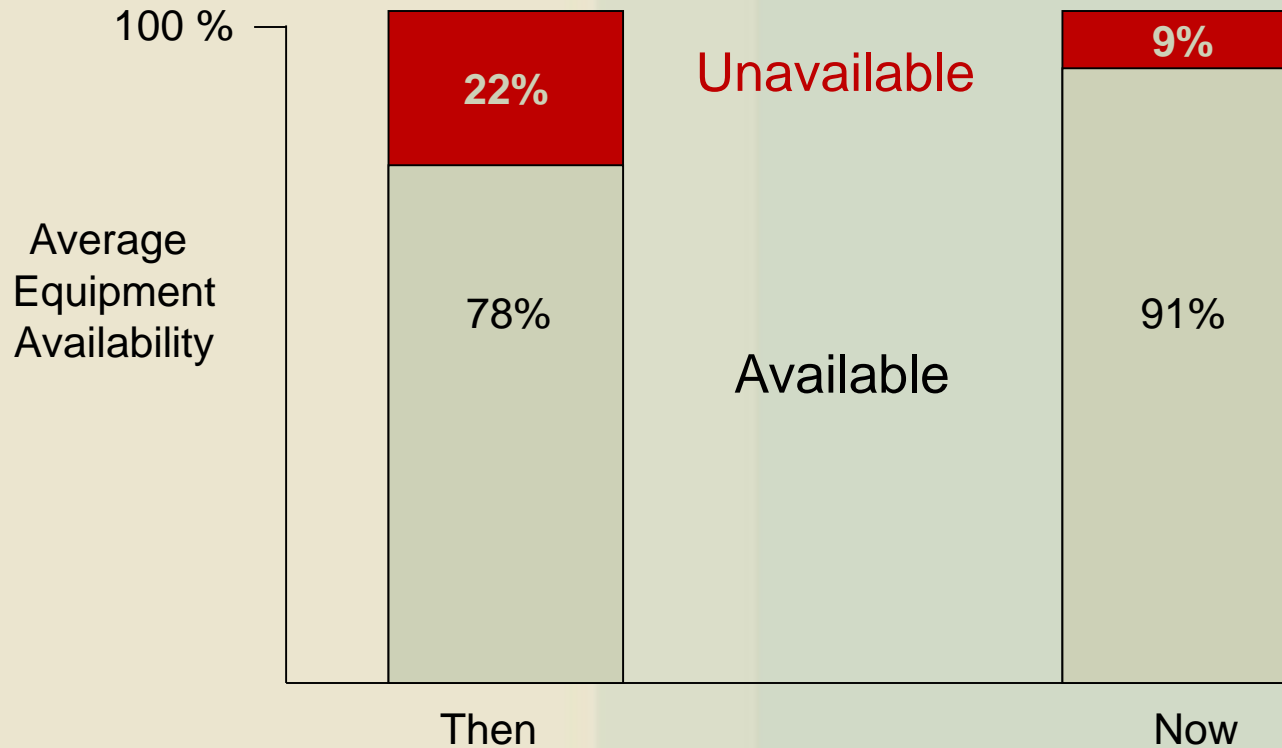
Dofasco Response

- A solution to the changing world of maintenance required a Reliability Driven Maintenance focus
 - Asset reliability business process
 - Maintenance & reliability practices
 - Enabling technologies
 - Sustained corporate commitment to reliability

The Results

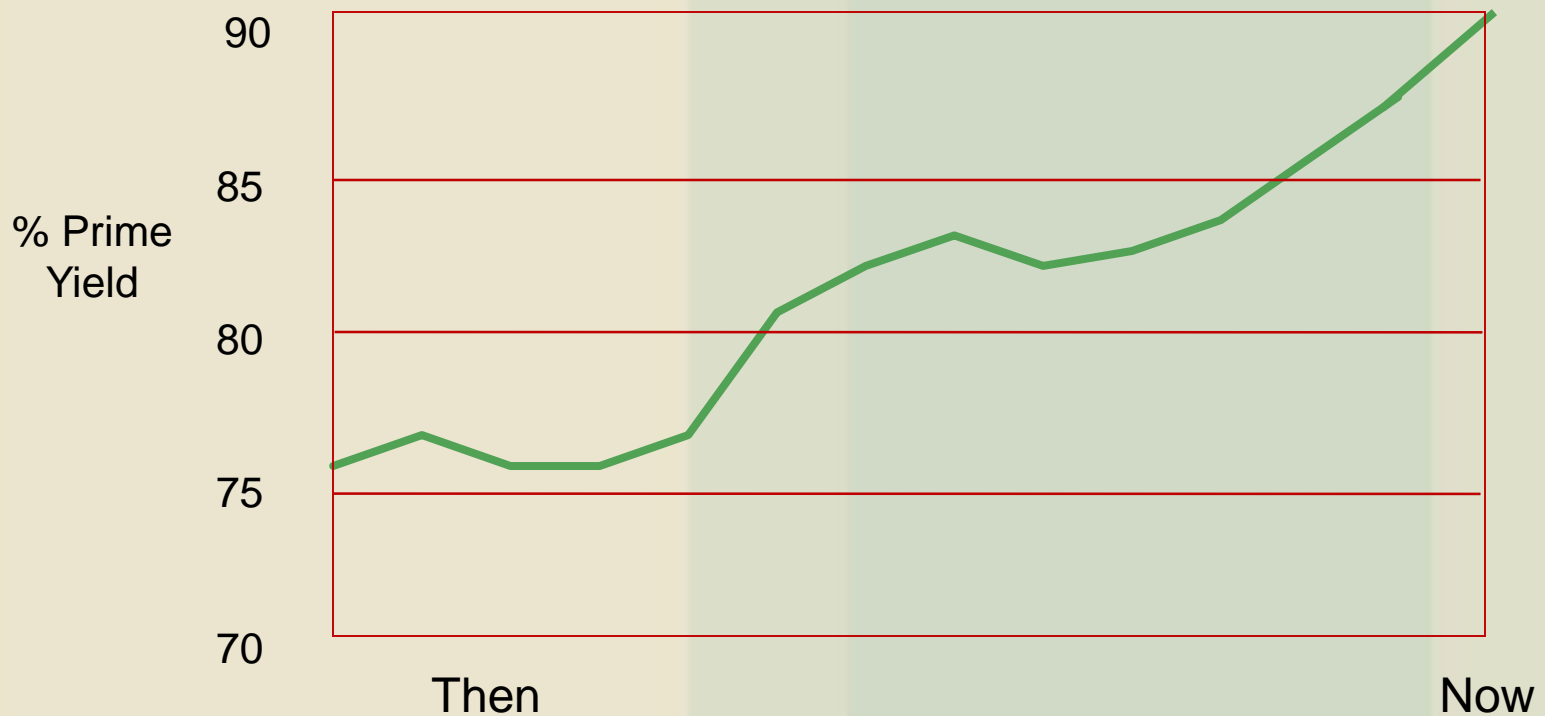


The Results



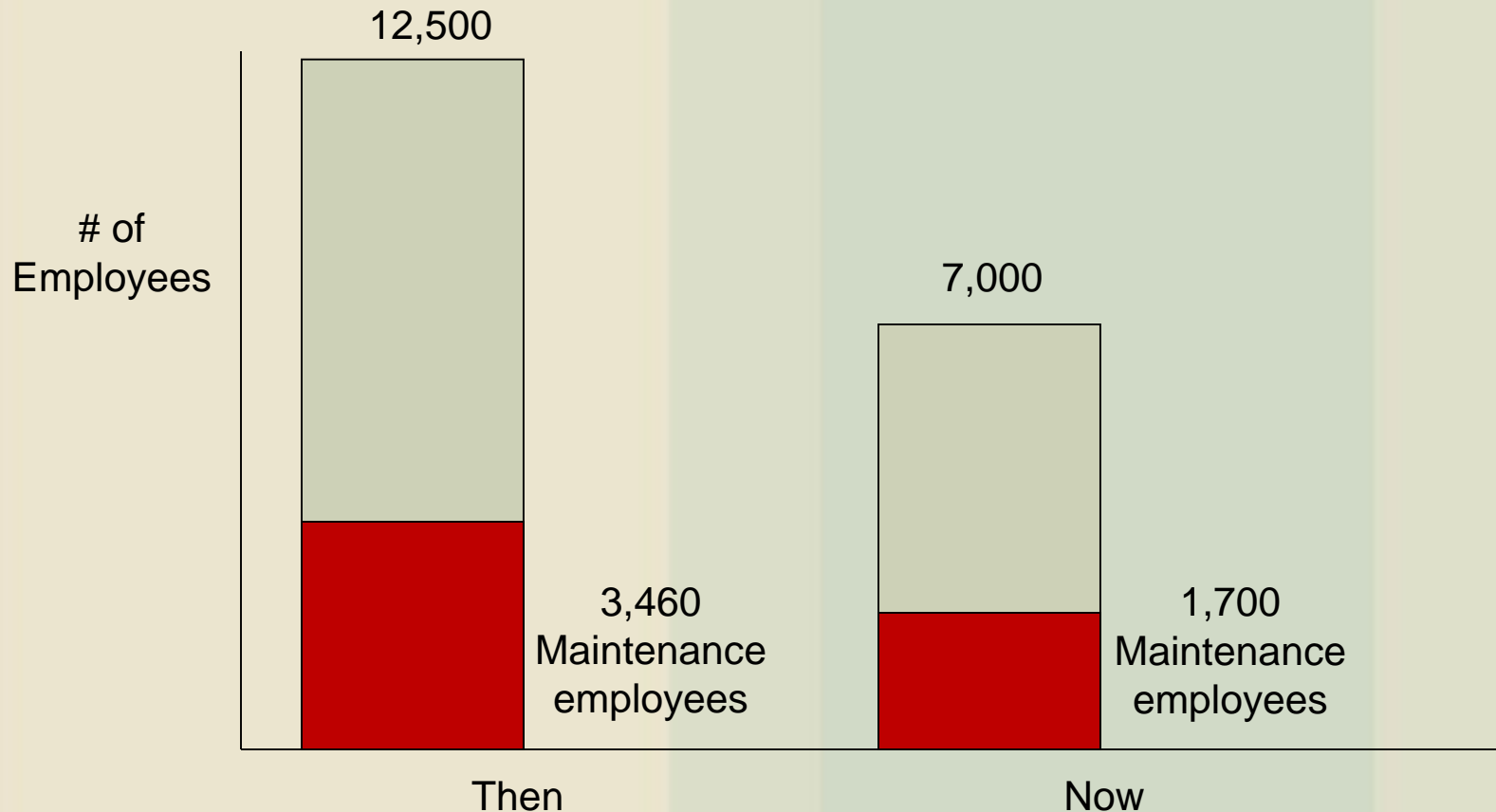
The Results

Quality increased from 76% yield to 91%



The Results

Reductions achieved through voluntary attrition



The Payoff

- Winner of two prestigious maintenance awards:
 - Best use of Innovation and Technology in Maintenance
 - Best Maintenance for a Large Plant
- Most Profitable North American producer in their sector
- Ranked as #1 worldwide manufacturer in their industry by Dow Jones 2 years running
- North American benchmark for World Class maintenance practices and technologies

Dofasco Maintenance Culture

- Historically Dofasco's maintenance department:
 - Repaired broken equipment
 - Or preferably, prevented equipment from breaking
- Majority of attention was to:
 - Improve trade repair skills
 - Optimize time based equipment overhauls
 - Better use of advanced planning & scheduling tools
- “Equipment Repair Culture” rather than an “Asset Management Culture”

Asset Management Culture

- Higher market demands
 - Quality
 - Price
 - Delivery
- Increasingly stringent safety and environmental regulations
- Equipment becoming increasingly complex
- New research on modes of equipment failure
- New computer and diagnostic technology
- New failure paradigm

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Dofasco Background & Research

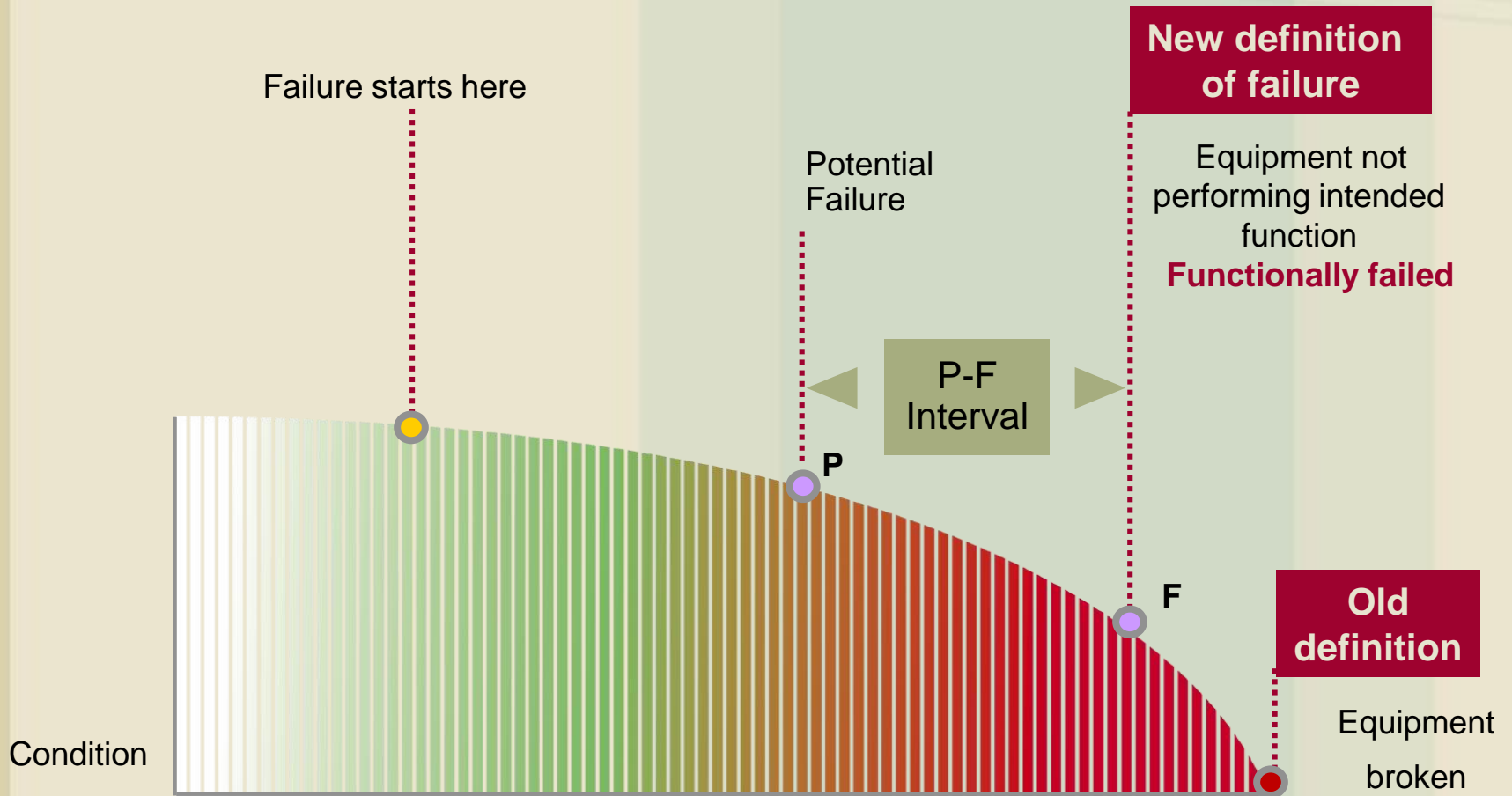
Dofasco Response & Results

New Failure Paradigm

Integration with OSIsoft PI

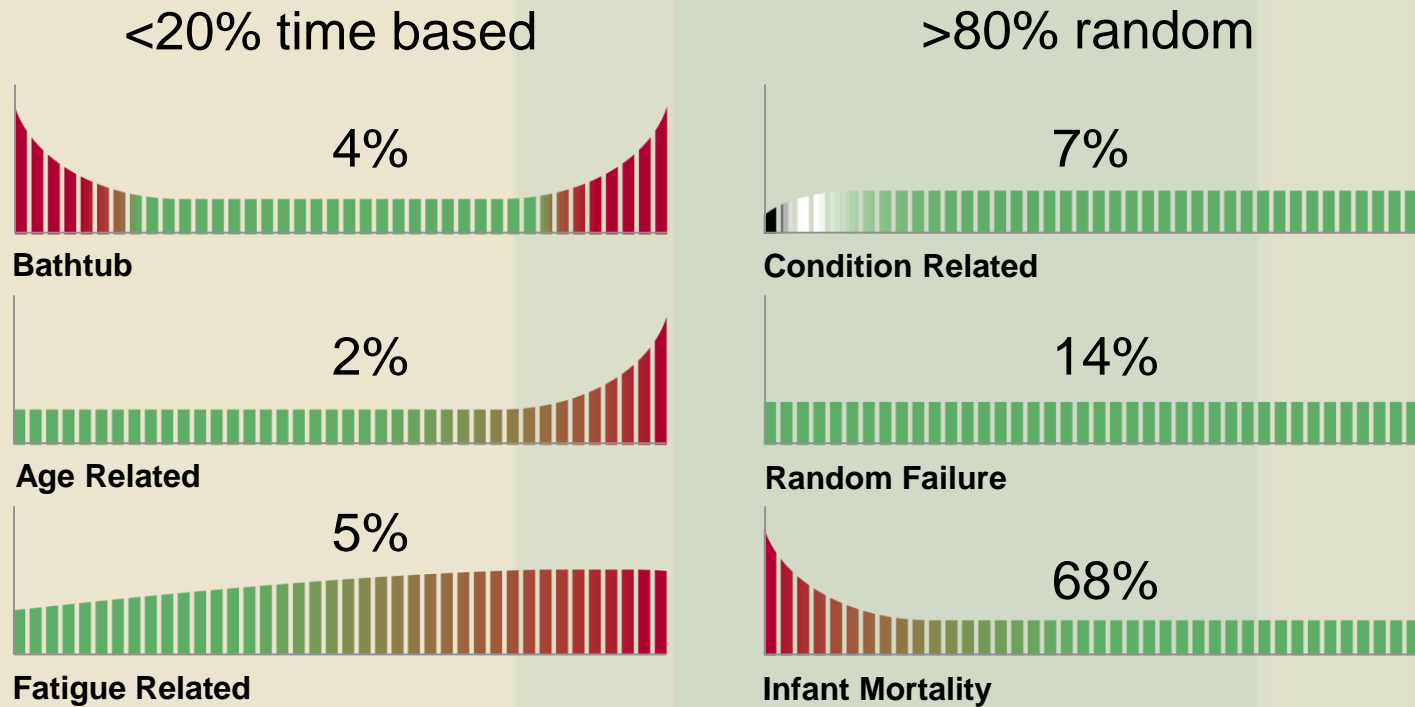
Case Study

New Failure Paradigm



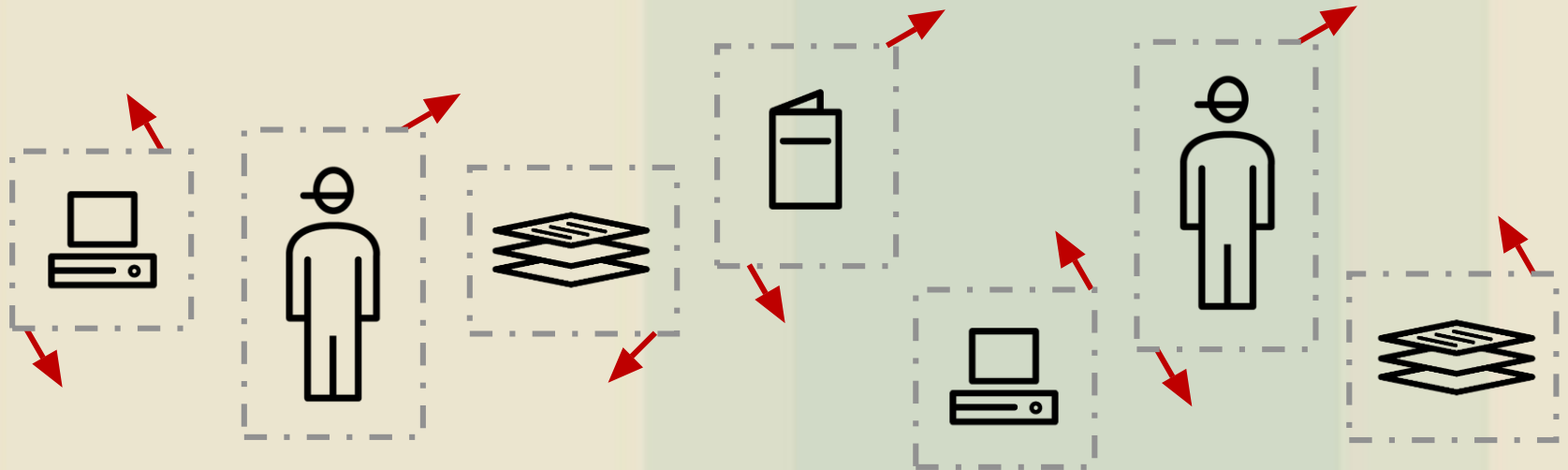
The Reality of Failure

- There are six failure patterns



The majority of failures are random, not time-based

Typical Current Situation

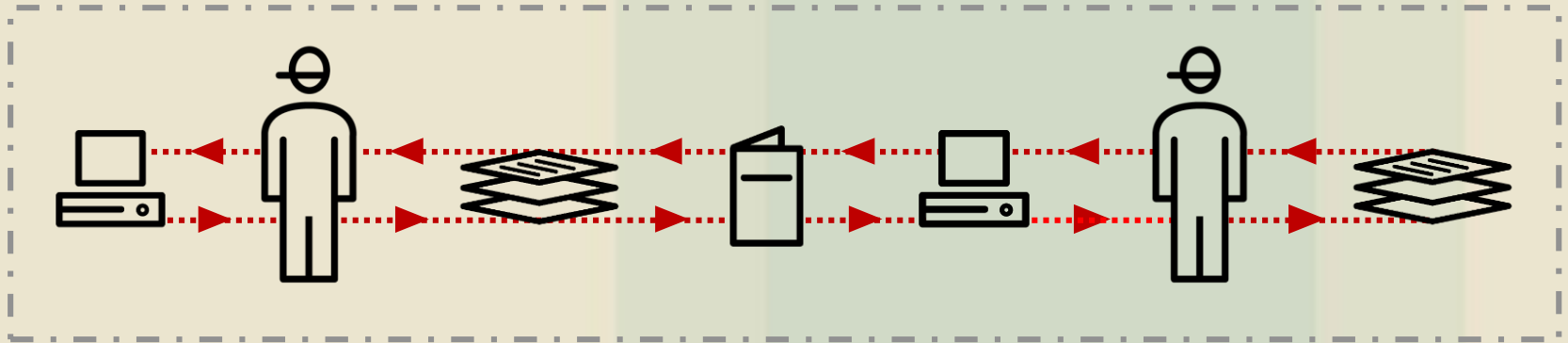


Scattered
knowledge

Inconsistent
actions

What Maintenance
Work?
At What time?

Preferred Situation



business process and practices

Consistent organized
way to capture and
use Knowledge &
Information

actionable knowledge

Information System
provides easy access
to a Common
Knowledge
Repository

consistent action

*The Right Work
at
The Right Time*

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Dofasco Background & Research

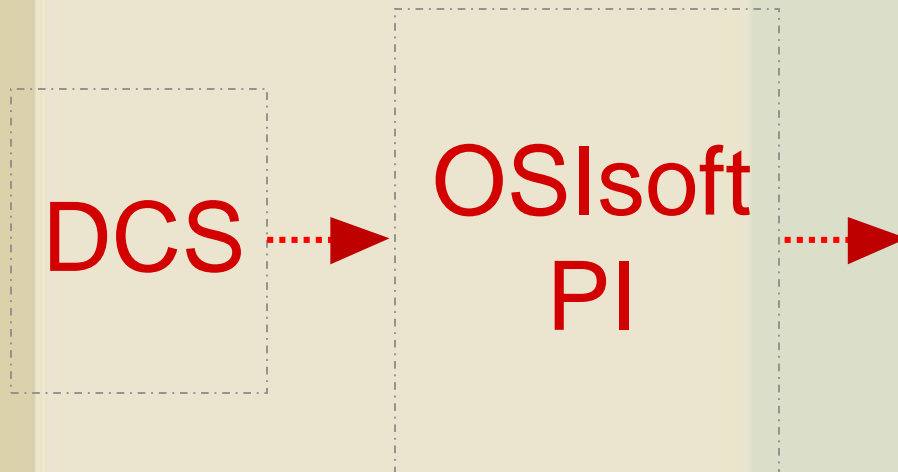
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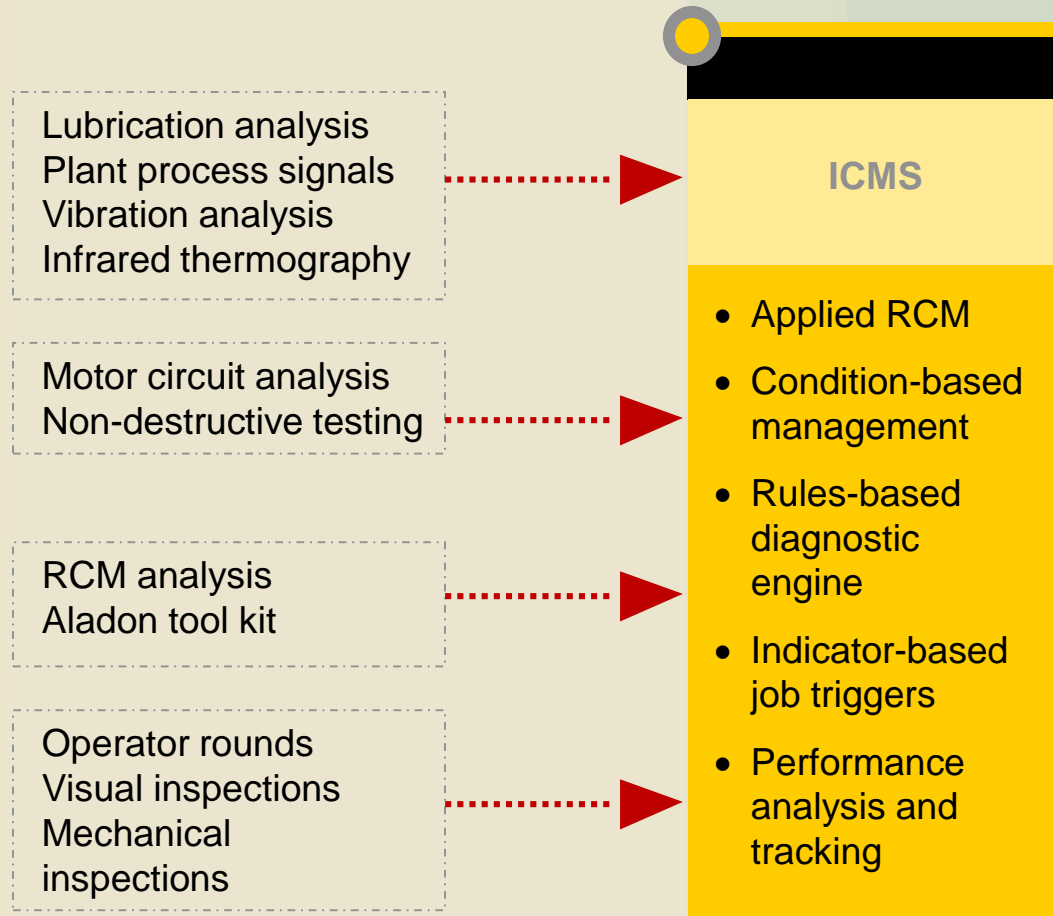
Integration with OSIsoft PI



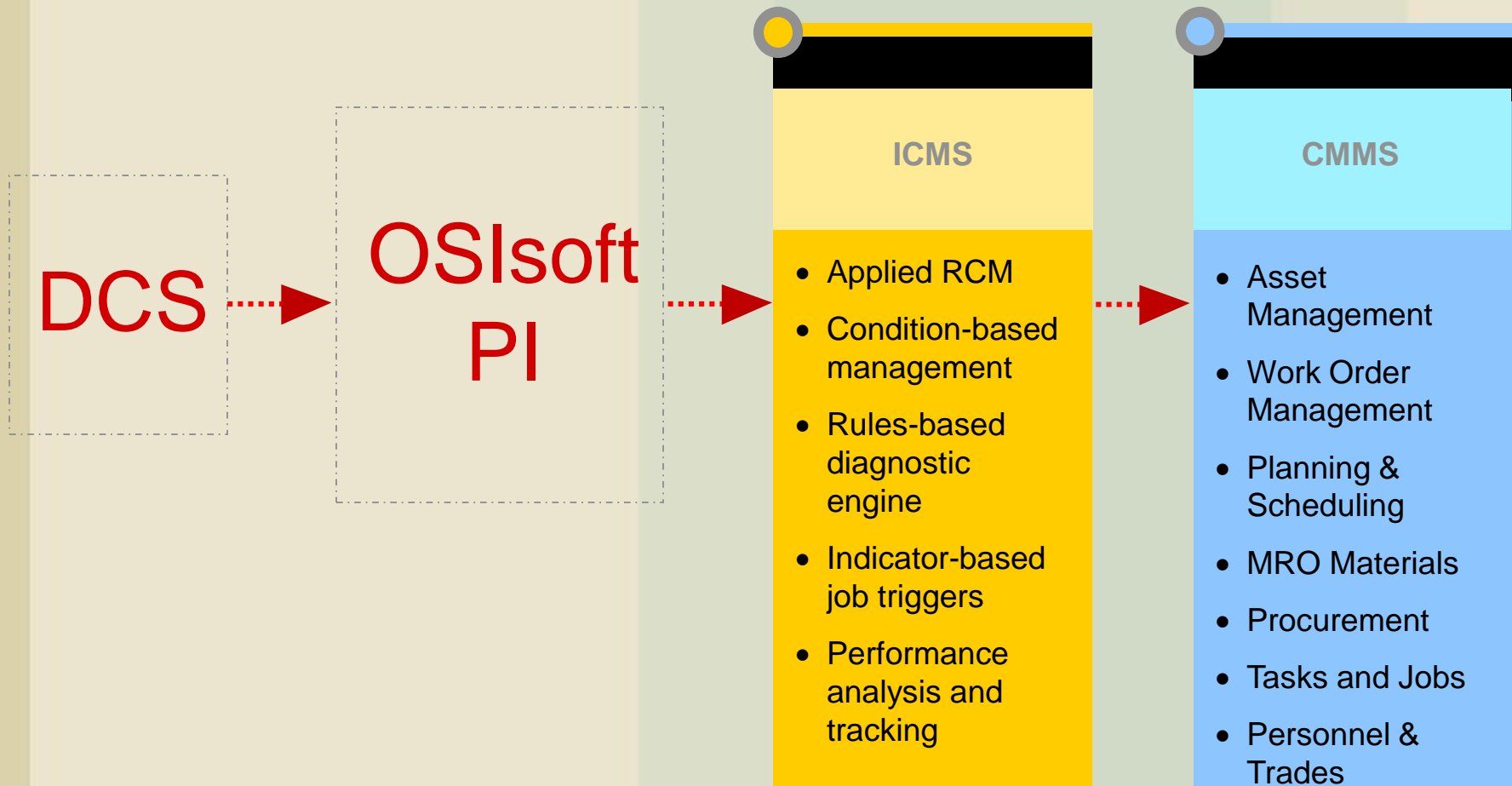
CMMS

- Asset Management
- Work Order Management
- Planning & Scheduling
- MRO Materials
- Procurement
- Tasks and Jobs
- Personnel & Trades

Integration with OSIsoft PI



Integration with OSIsoft PI



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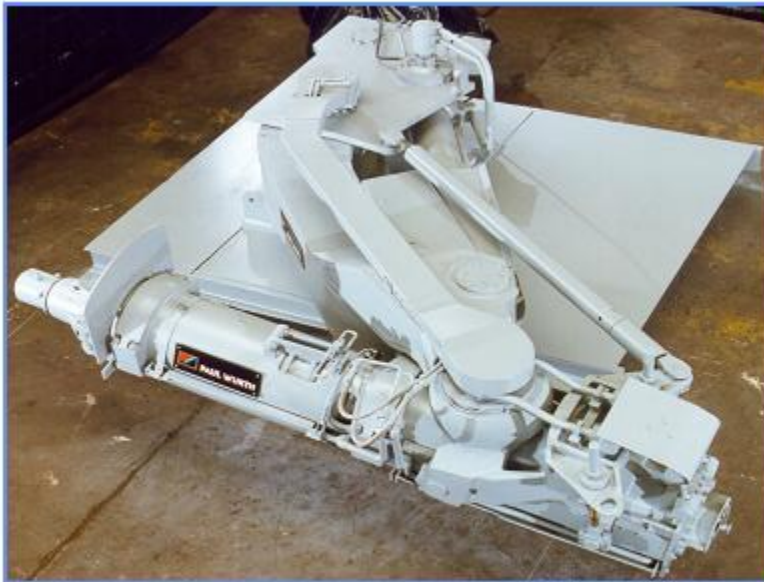
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Integration with OSIsoft PI

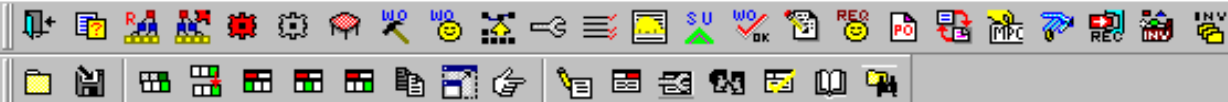
Case Study

Case Study:

Using PI Data Collector to Improve Equipment Reliability



File Edit View Analy/ID Plan/Sched Exe/Followup Purch Stores Window Help



RCM Information Worksheet - [THFSWING]

Asset: Tap Hole / Swing Cylinder System

Reference: THFSWMNG

Approved ☐ Audit Trail ☐

	Functional Failure	Failure Mode	SA	Failure Effect
1	Swing Cylinder fails to properly position mudgun cylinder over taphole.	1 Furnace tap hole face builds up during casting.		Once the furnace taphole has been drilled, molten iron is released to atmosphere, and pours into the trough runner system. As the molten iron is released, it sprays over the existing equipment
2		2 Furnace tap hole erodes during normal use.		During normal furnace operation, and when the furnace is tapped, the flow of molten iron travels over the tap hole refractory. Over time, the tap hole refractory lining erodes, and follows same as
3		3 Swing Cylinder hydraulic system fails.		To be analyzed separately.
4		4 Swing Cylinder extend cylinder limit fouls.		Over time, the release of molten iron spray from the furnace tap hole, settles on the Swing Cylinder extend limit, and eventually melts the limit switch. next Swing Cylinder sequence,

An RCM analysis was done to identify the maintenance program for this asset

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RCM Decision Worksheet - [THFSWING]

Asset: Tap Hole / Swing Cylinder System

Reference: THFSWMNG Approved ☐ Audit Trail ☐

Task Selection			Default Tasks			Maintenance Decision Activity Type	Proposed Maintenance Decision Description	Initial Interval
1	2	3	H4	H5	S4			
Y						On-Condition	Survey Tap Hole position after every trough rebuild, with survey & laser equipment. Re-surface tap hole if required.	4. WEEK(S) [Time]
Y						Corrective	Based on results of survey above, clean tap hole race as required.	
N	N	N				Redesign	Investigate the installing protection covers over the Swing Cylinder extend limit.	

One of the Maintenance activities identified was an On-Condition task to determine tap hole face condition with survey equipment.

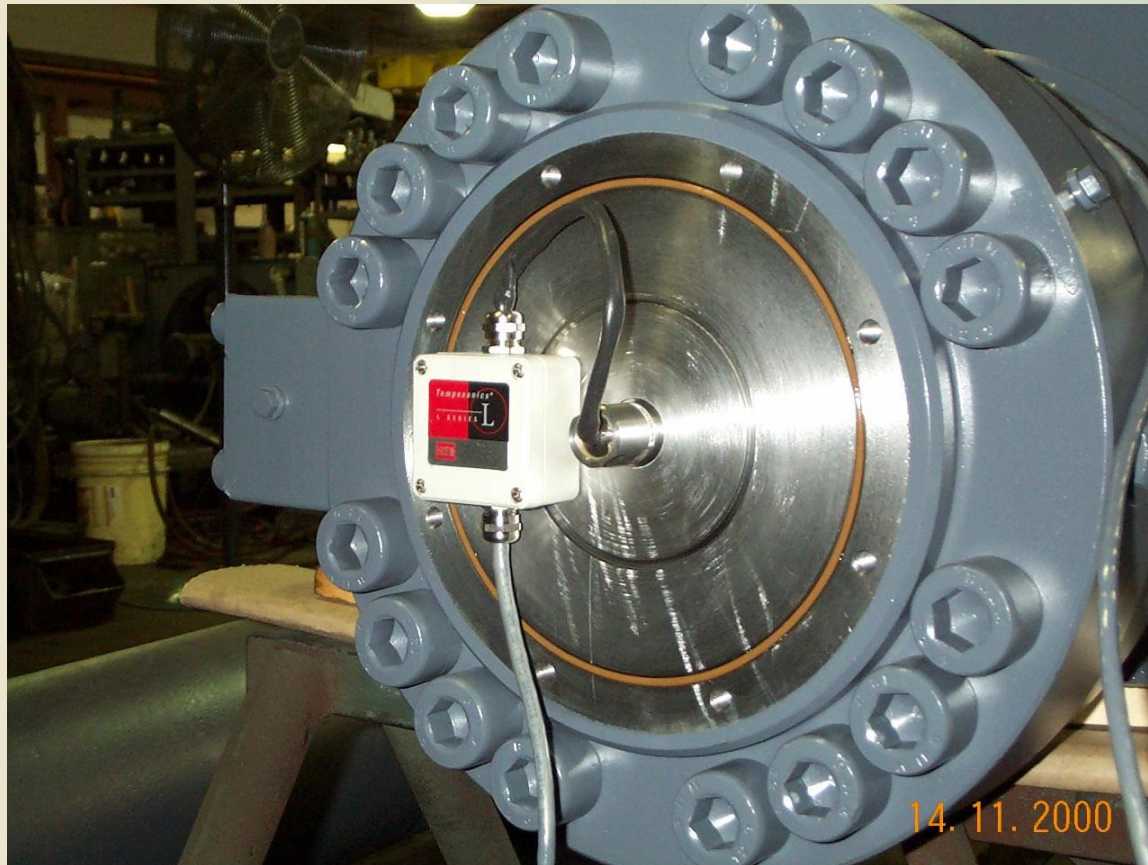
Before PI Implementation

- Tap hole position was collected after every trough rebuild
- Performed manually with surveying and laser equipment
- Based on the results, the Tap hole face was re-surfaced

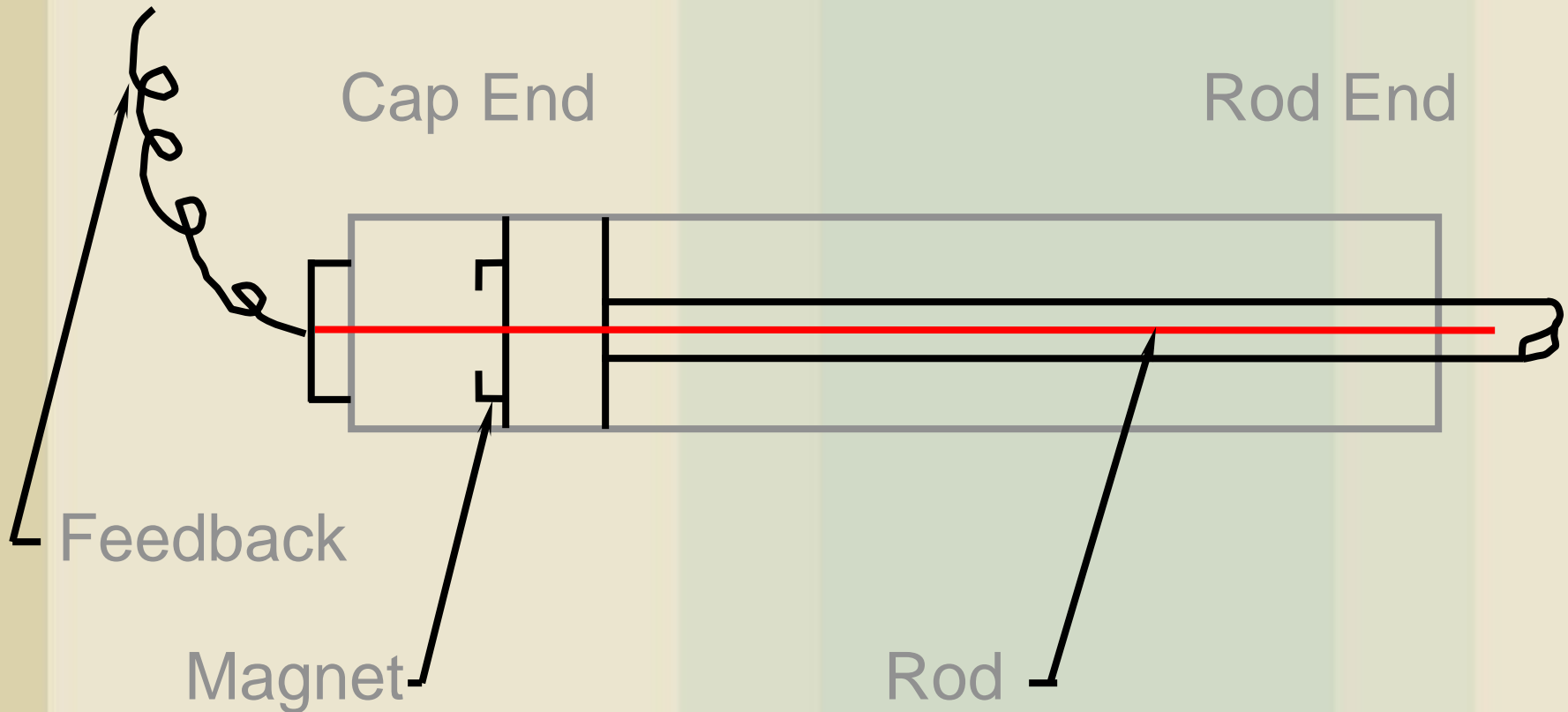
PI Implementation Requirements

- Installed Linear Voltage Differential Transducer (LVDT) into the end of the Swing Cylinder
- Calibrated the LVDT to Tap Hole Face based on a cylinder stroke of 1370mm
- Maintenance and Operations determined the effective stroke ranges of the cylinder required by the process

Swing Cylinder with LVDT



Cylinder Schematic



CMMS Production

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Activity Description - [242317]

Actv Title: #4BF-East Swing Cyl LVDT PI Test

Actv Type: On-Condition **Equip Type:** CYLINDER-HYDRAULIC

PM/PdM Tech: PERFORMANCE ANALYSIS-ON-C-MECHANICA **Location Cd...** BAYN.PROC.IRON.BF4.CAST.GUDR.EGUN.SWMP

PdM Test... **Equip Location:** 4BF EAST CLAYGUN - SWMNG CYLINDER

Activity Description: This activity was created to collect data automatically, via the PI / CMMS Interface. There is one indicator that is monitored. Certain process criteria must be met before data will be captured. The first being linear motion of the hydraulic cylinder (ZI-D879). If the linear motion of hydraulic cylinder is measured to be 0 - 1370 mm, the process data is captured, and stored.

Performance Details

Req Dept: IRNM - IRONMAKING MAINTENANCE

Craft **Staff Regd** **Actv Craft Dur (HH:MM)**

Attachment: ☐ Actv Duration (HH:MM): 00:00

Standards: ☐ Tot Actv Labour Hrs (HH:MM):

Created By.../Ext: 26199 HRIBLJAN, FRANK 6382

Conditions

☐ Downtime Req'd
 ☒ Steady State
 ☒ On Location
 ☐ Disassembly Req'd
 ☐ Coast Down

Maintenance Period

Interval: .5 MINUTE(S) [Time]

Fixed: Y

Open Activity Description

CMMS Production

File Edit Analy/ID Plan/Sched Exe/Followup Purch Stores Window Help

Analysis Technique: Fixed Limits - [33323/242317/40]

Condition Indicator Name: Length-Cylinder Stroke

Units: MM [[None]]

Equipment Location: 4BF EAST CLAYGUN - SWING CYLINDER

Severity	Limit	State
<input checked="" type="radio"/> Critical when exceeding	370.000	is HIGH CRITICAL
<input checked="" type="radio"/> Alarm when exceeding	1365.000	is HIGH ALARM
<input checked="" type="radio"/> Warning when exceeding	1360.000	is HIGH WARNING
<input type="radio"/> Normal when exceeding	1347.000	is NORMAL
<input checked="" type="radio"/> Warning when exceeding	1341.000	is LOW WARNING
<input checked="" type="radio"/> Alarm when exceeding	1335.000	is LOW ALARM
<input checked="" type="radio"/> Critical when exceeding	-9999999.000	is LOW CRITICAL

Ready

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ICMS External Data Collection Configuration - [Production]

File Edit View Mapping Window Help

Activity Mapping - [242317] #4BF-East Swing Cyl LVDT PI Test


Activity Mapping Details Indicator Links Pre-conditions

Sources

Source Summary

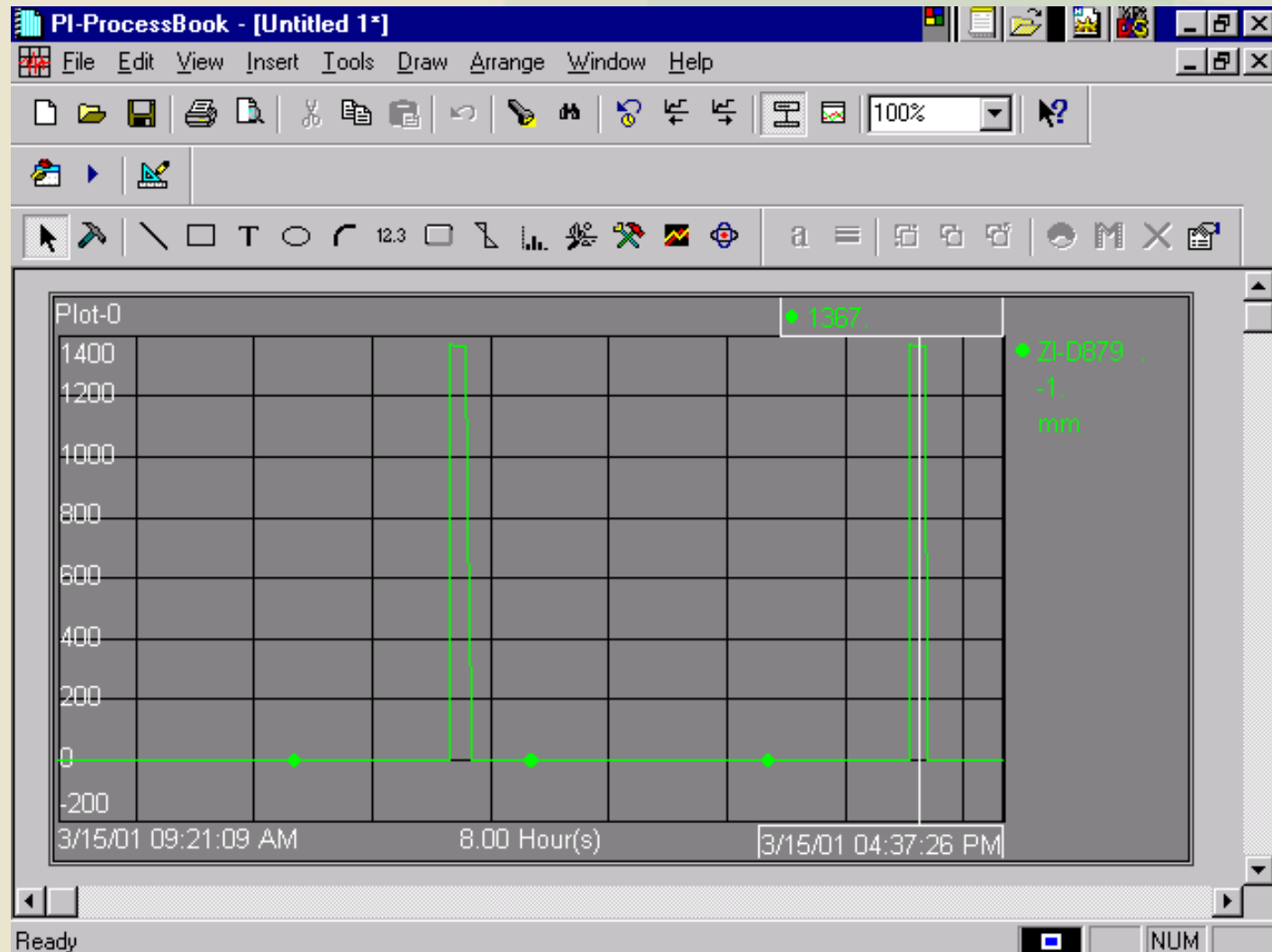
{Subsystem:Server} Tagname [Units] (Descriptor)

Activity Collection Pre-conditions

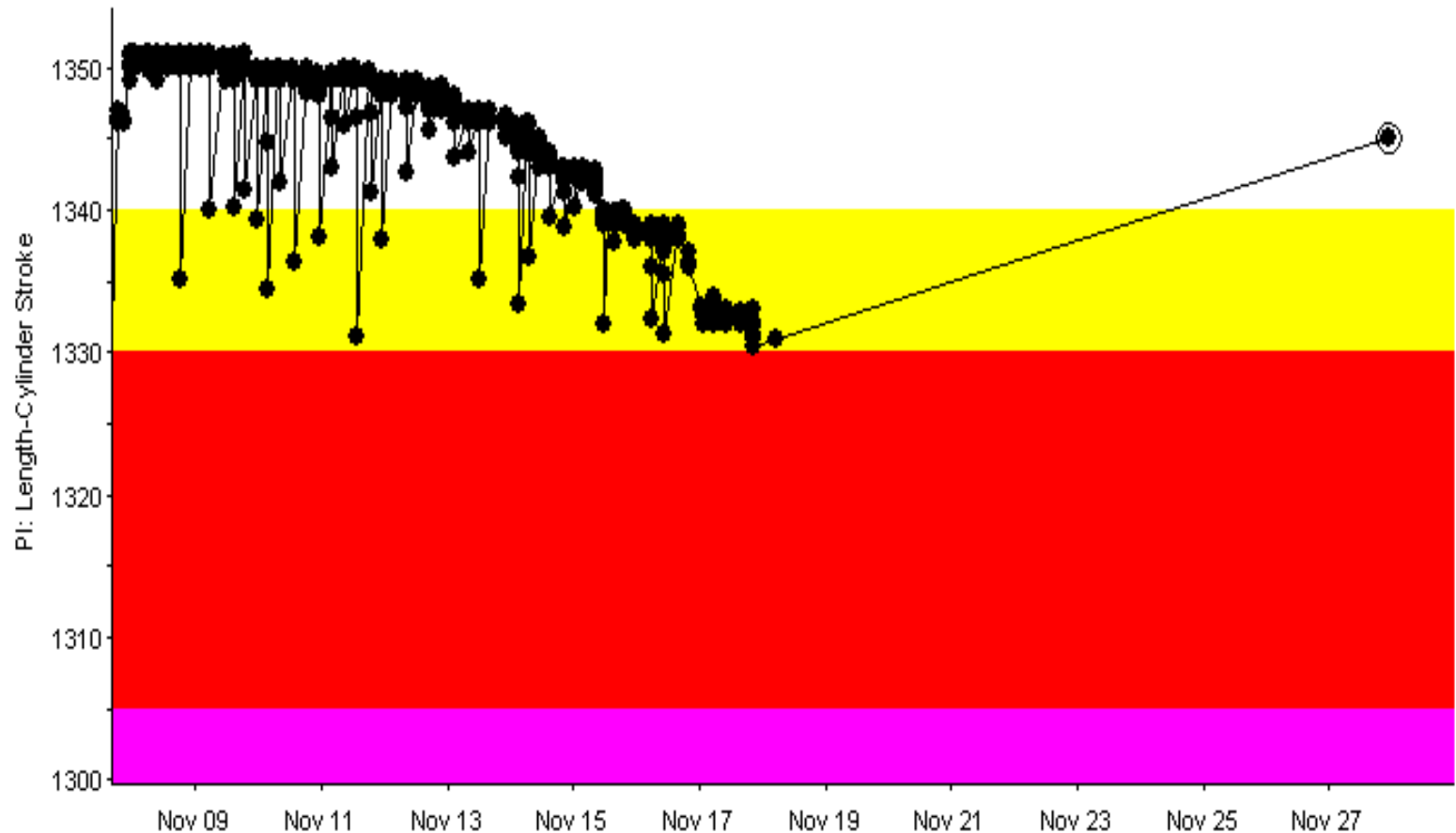
Source Summary	Operator	State... / Value	Value Toler. ±	Duration	Units
 {PI:SDSYS} ZI-D879 . [mm] (East Mudgur	<	1380	50	0.5	MINUTE(S)
	>	1330			

Search for Activities

After PI Implementation



Graph - BAYN.PROC.IRON.BF4.CAST.GUDR.EGUN.SWIN.CYL: PI: Length-Cylinder Stroke vs Date



We can visually see how mudgun nozzle to tap hole face fit has deteriorated into alarm

The stroke of the Swing Cylinder has gone into alarm relative to the pre-determined levels identified when the maintenance program was set up.

File Edit View Analy/ID Plan



The alarm is shown to be caused by the failure mode “Re-Surface East Tap Hole Face”.

Equipment Location Failure Mode - [36893]

Failure Mode: Re-Surface East Tap Hole Face

Description: The east tap hole face has fouled to the point where the proper amount of clay from being jeopardized. This prevents the proper amount of clay from being

Target Loc Cd... BAYN.PROC.IRON.BF4.CAST.GUDR.EGUN.SWIN.CYL

Target Equip. Type: CYLINDER-HYDRAULIC

Failure Mode No: 36893 **Created:** 02/25/2002 08:59 **Origin:** EMP

Created By: 27314 Djuric, Vlada 2043

The list of condition indicators values that triggered the fault are listed.

	Source Location Code...	Activity No	Indicator Name...	Operator	Indicator Status I
<input type="checkbox"/>	BAYN.PROC.IRON.BF4.CAST.GUDR.E	242317	Length-Cylinder Stroke	<	NORMAL
<input type="checkbox"/>	AND BAYN.PROC.IRON.BF4.CAST.GUDR.E	183333	Pressure-Hydraulic System (P.S.I.)	>	Low Pressure Alarm
<input type="checkbox"/>	AND BAYN.PROC.IRON.BF4.CAST.GUDR.E	183333	Pressure-Hydraulic System (P.S.I.)	<	Above Normal

Bench WOs

	Perf. Dept.	WO No.	WO Description	Req. Action (Days)
<input type="checkbox"/>	RNM	123154	RE-SURFACE & REAM #4BF TAP HOLE FACE & TAP HOLE	1

The recommended sequence of corrective work to rectify the problem is provided.

An Automated Work Request was generated by the EXP to re-surface and ream the furnace tap hole. After the supervisor/planner approved the Automated Work Request, the company's CMMS planned, scheduled and generated the Work Order necessary to have the work completed.

The screenshot shows a 'Work Request - [new]' form with the following fields and values:

- Reqst No./Group No: [] []
- Perf Dept: IRON
- Job Priority: 0
- Shutdown No: []
- Created: 02/26/2002 11:18
- Sugg Bench Dept / WO: IRNM
- 123154
- ICMS Sugg Route: []
- Auth. by/Date: [] []
- Orig Dept.../ WO: IRNM
- Reqd by Date: 02/26/2002
- Originator.../Ext: 2734 Djuric, Vlada 2043
- Assigned to.../Ext: 17756 Viecei, Renzo G A 4506
- WO/Maint Type: CO RP NI
- Contact Empl.../Ext: 26199 Hribljan, Frank 6382
- Equip Loc. Desc: 4BF EAST CLAYGUN - SWMNG CYLINDER
- Work Reqst Desc: RE-SURFACE & REAM #4BF EAST TAP HOLE
- Cost Ctr/Acct: 7234 904 000
- Project No: []
- Created WO No: []
- More Notes: []
- Matl/Date Expt: [] []
- Call Req Flg: []
- Send Dwg: []
- Suggestion No: []
- Rtn To Gate/Door: [] []
- Sin Dwg No: [] [] []
- Item: []
- Stock Cd.../Qty: [] []
- Part Dwg/Item/Ind: [] [] []
- Mfg Cd: []

Red circles highlight the text 'ICMS Initiated' and 'Work Reqst Desc: RE-SURFACE & REAM #4BF EAST TAP HOLE'.

Graph - BAYN.PROC.IRON.BF4.CAST.GUDR.EGUN.SWIN.CYL: PI: Length-Cylinder Stroke vs Date



The work initiated by Dofasco's ICMS system, with the help of the PI Interface, resulted in a complete recovery of mudgun nozzle to tap hole fit, saving the company \$1 million per year, for every year the furnace operates past an 8 year campaign. The poor fit between the mudgun nozzle to tap hole, would not have been evident or remedied by the operators, based on existing control room data.

Benefits of PI Integration

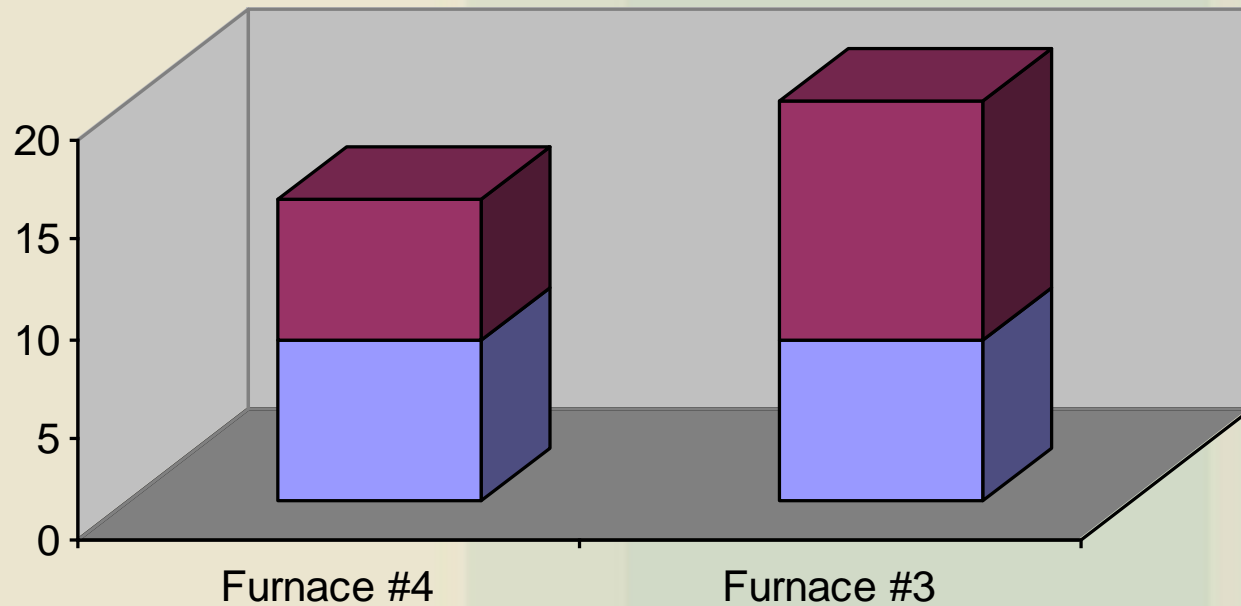
- Collecting important equipment indicator information automatically and more often
- Early warning of impending failure
- Scheduling the right work at the right time
- Significantly increased time between furnace re-linings

Benefits of PI Integration

- Savings
 - Furnace #4
 - Extending campaign from 8 years to 15 years
 - Save \$1 million per year after 8 years = projected \$7 million
 - Furnace #3
 - Extending campaign from 8 years to 20 years
 - Save \$1 million per year after 8 years = projected \$12 million
 - Total Projected Savings
 - \$19 million (just for this one example)

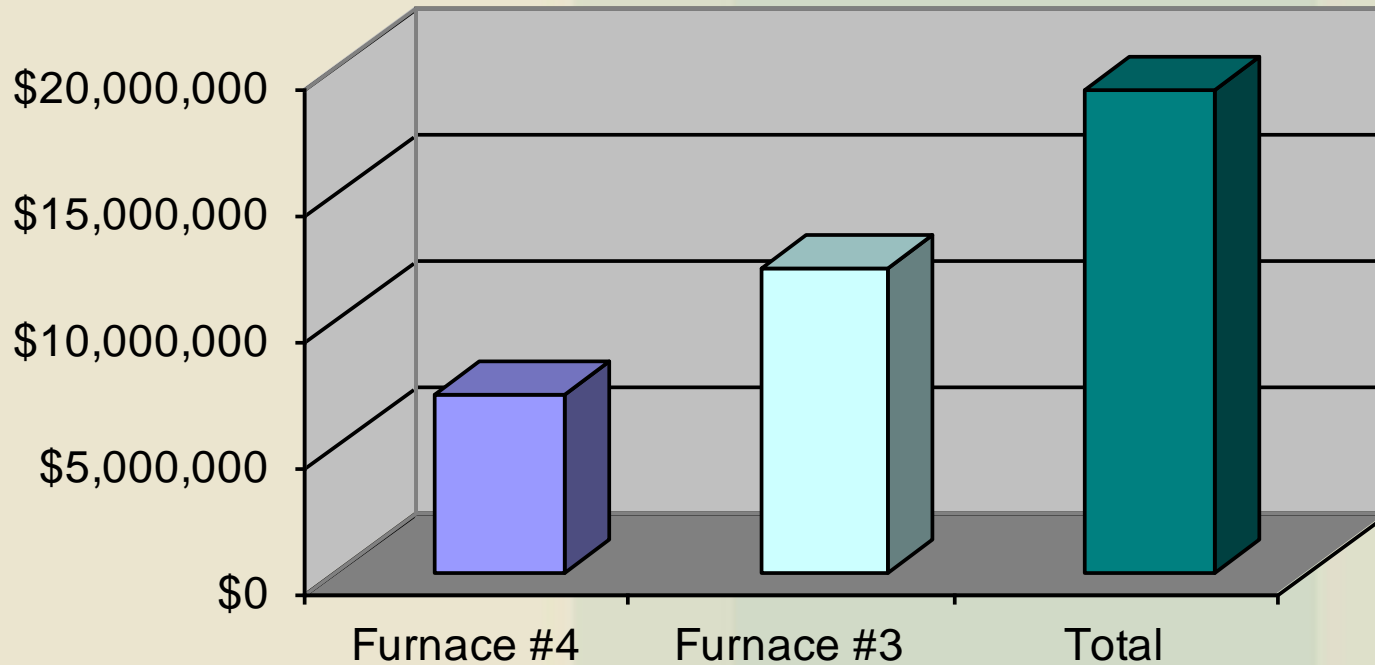
Benefits of PI Integration

Extended Furnace Campaigns (Projected)



Benefits of PI Integration

Projected Savings



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Questions?

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