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## **How to Facilitate Equipment Reliability Analysis**

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# Agenda

- About DuPont
- Project Background
- Equipment Reliability Enhancement Project
- Results Achieved
  - Early insights
  - Reliability Network
  - Reliability Improvements Projects

# Agenda

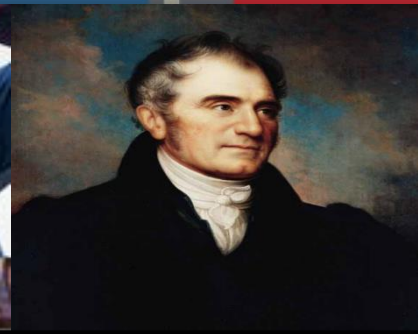
## ■ About DuPont

### ■ Project Background

### ■ Equipment Reliability Enhancement Project

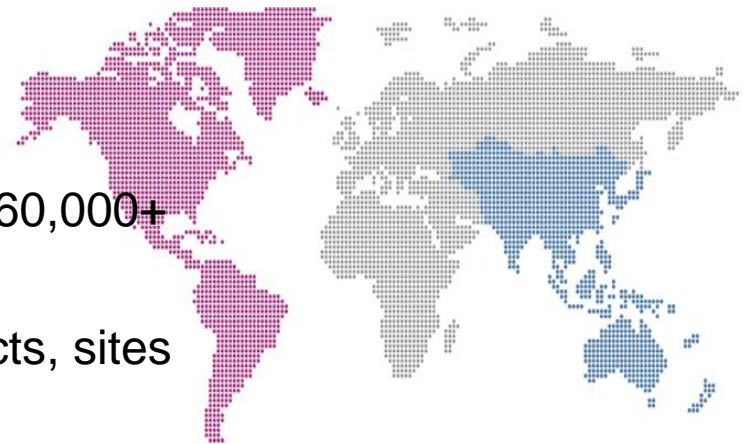
### ■ Results Achieved

- Early insights
- Reliability Network
- Reliability Improvements Projects



# About DuPont

- DuPont is a Global Science Company established in the 1802 by Eleuthère Irénée (E.I.) du Pont
- “We deploy our World-Class Science and Engineering to seize market opportunities and solve some of the world’s biggest challenges.”
- Worldwide reputation for industrial safety
- Locations all around the world employing 60,000+
- Diverse manufacturing processes, products, sites



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■ About DuPont

■ **Project Background**

■ Equipment Reliability Enhancement Project

■ Results Achieved

- Early insights
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- Reliability Improvements Projects

# Background

- Ever struggled to use your CMMS data to understand and drive reliability work?
  - Understanding big failures is pretty straightforward but getting to the smaller incremental improvements needed requires more extensive use of data
  
- Do you have a need for a smarter way of handling equipment failure data
  - Large amounts of work order history of variable quality
  - Unable to see 'The Wood for the Trees'
  
- Would you like to engage your maintenance team more in equipment reliability improvement?
  - Improving the quality of the data where it counts
  - Making sure the right work is being done with the right people

# Background

- DuPont Luxembourg has had a good track record for overall asset care focusing mainly on a preventive maintenance programme
- Business pressure to increase capacity without additional cost has required a more rigorous approach to using data to
  - Eliminate defects
  - Optimise existing maintenance strategies
  - Prioritise projects
- Data from different sources had been gathered over time however equipment history very often was not used to support decision making with respect to equipment reliability projects or predictive/ preventive maintenance strategy.
- The process for equipment reliability analysis was very limited



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■ About DuPont

■ Project Background

■ **Equipment Reliability Enhancement Project**

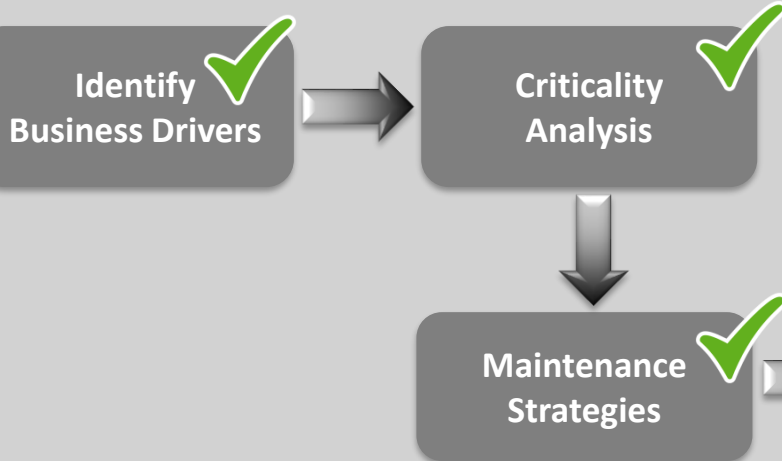
■ Results Achieved

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# Asset Care Management - Overview

## MIQA\*

### Strategy Development



### Re-evaluation



Analyse Event Data  
Reliability Analysis

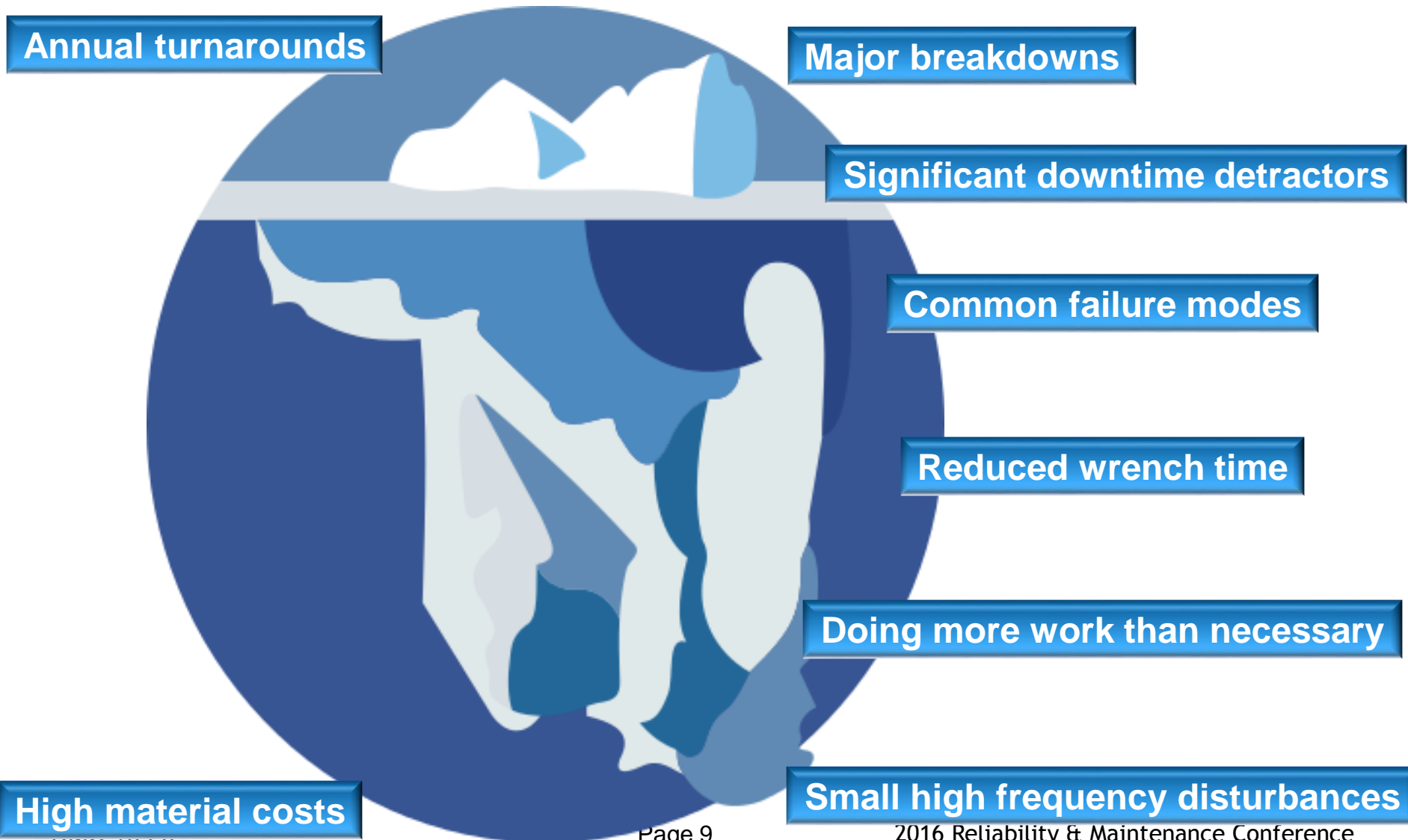


## Work Management Process

### CMMS



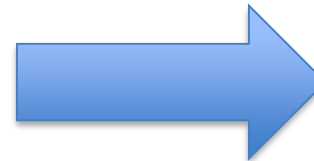
# Reliability Iceberg



# The Objective of the Equipment Reliability Enhancement Project



- Better use of the CMMS (SAP) work history data
- “Maintenance work history” good quality
- Analysis of failures and associated risk
- Identify potential Bad Actors
- Prioritize Improvement Work
- Eliminate Defects



**Reduce Reactive Work**

**Optimize Preventive/  
Predictive Maint.**

**Increase Plant Reliability**

**Cost Reduction**

# Challenges = Opportunities



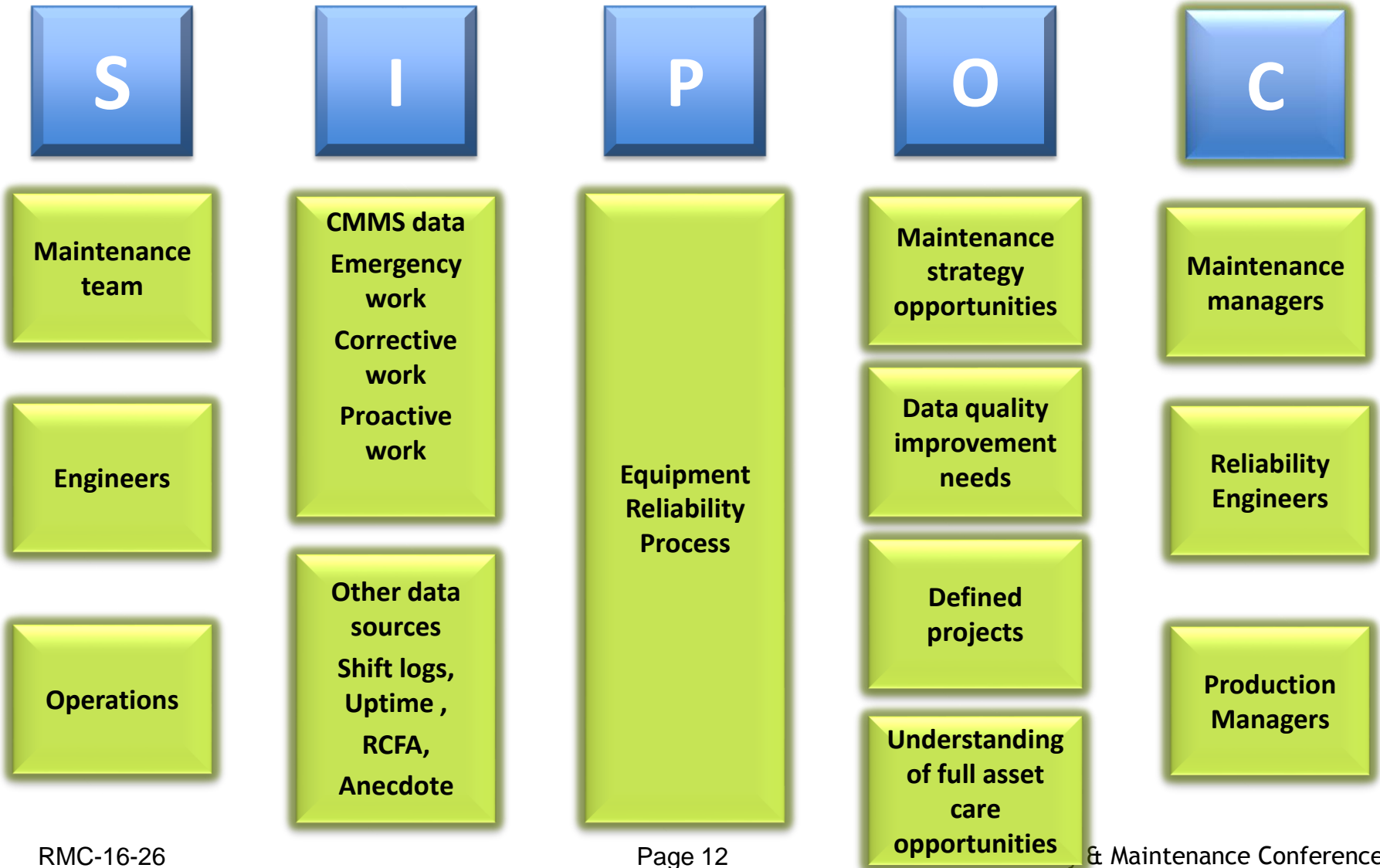
## Challenges:

- ❑ No standard process in place for Reliability Review
- ❑ Insufficient understanding of the correct SAP transactions to be used
- ❑ A concern that the data needs to be 100% accurate
- ❑ All reports are hand created by gathering data from different sources
  - ❑ Time consuming
  - ❑ Higher chances for error
- ❑ Insufficient knowledge of analytical tools
  - ❑ Reliability Software rarely used

## Action Plan

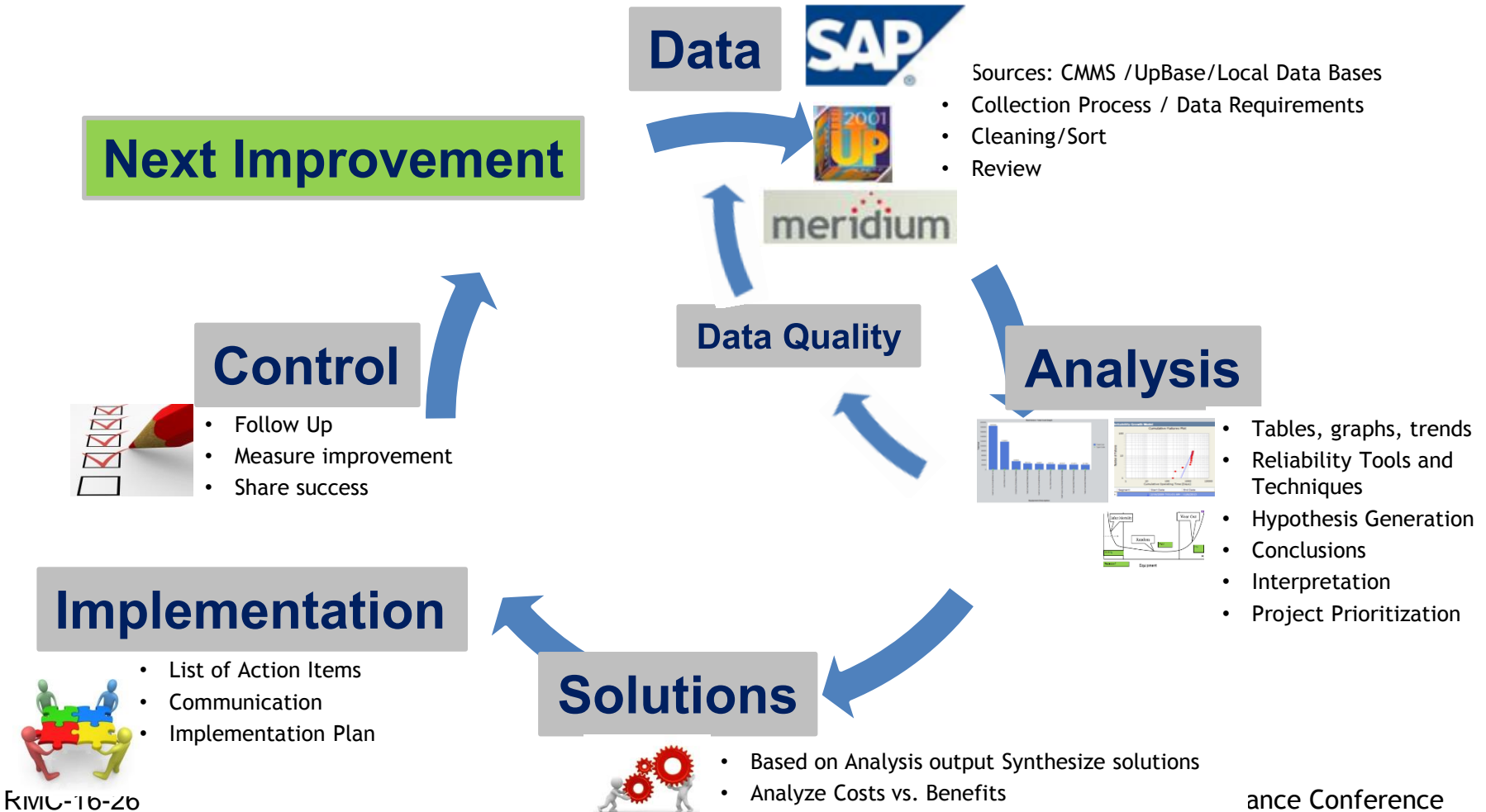
- ❑ Develop the Standard Process for Equipment Reliability Analysis
- ❑ Automate process of data extraction and initial preparation
- ❑ Develop the training package for the Reliability Engineers

# Process Map



# Standard Process for Reliability Analysis

The Process Flow was developed to Define the Steps, the Structure, Roles and Responsibilities for a Standard Reliability Review.



# “Automatize” the Data Preparation Process

The COE\* together in collaboration with Luxembourg Site created a Tool that:  
COE - Center of Excellence

## Extract data out of SAP

A	B	C	D	E	F	G	H	
1	Date scope	DATE START	DATE END	Run Date	Start Time	Comp Time	Status	Worksheet
2	IW49	01.01.2015	31.12.2015	20.01.2016	3:00:45 PM	3:02:07 PM	Complete	IW49
3	IW47 (input date range)	01.01.2015	31.12.2015	20.01.2016	3:02:07 PM	3:10:31 PM	Complete	IW47
4	IH08			20.01.2016	3:10:31 PM	3:11:45 PM	Complete	IH08
5	IH06			20.01.2016	3:11:45 PM	3:12:20 PM	Complete	IH06
6	ZYFM_102	01.01.2015	31.12.2015	20.01.2016	3:12:20 PM	3:13:16 PM	Complete	ZYFM_102
7	ZYFM_104	01.01.2015	31.12.2015	20.01.2016	3:13:16 PM	3:18:28 PM	Complete	ZYFM_104
8	IF18			20.01.2016	3:18:28 PM	3:18:51 PM	Complete	IF18

<b>Extract Selected Data</b>		Start	3:00:45 PM
		End	3:18:51 PM
		Last running time (tot.)	00:18:06
		File Version	P02

Site Parameters	stPlant	MainPlant	stFunLoc	stFunLoc2	stFunLoc3	Extraction Language (SAP Login)	Curr - EUR or USD



Automate Data Extraction

- Time Reduction
- Standardization



Use of the correct SAP transactions

- Pre-define transactions filters
- Pre-defined reports layout
- Error-proofed

## Compile the data reports & Initial data cleaning and preparation

Reactive/ Preventive/ Other	Short text	Created on	Act. start	Act. Finish	System status	User status	ActTotCost	Contractors cost booked	Material Co booked
Reactive	E-Build Warmwasserkreis: Wassersschlag	20/04/2015	23/04/2015		CLSD PCNF PRT NMAT PRC SETC	MATR POK	253,60	0,00	
Other	M&M Schlägechraub: 2+3 Stock austauschen	17/11/2015	27/11/2015		REL PCNF GMPS PRRT PRC SETC	MATR POK	877,80	0,00	68
Reactive	Finish: Staubsauger Anschluss gebrochen	26/01/2015	27/02/2015		TECO PCNF PRT GMPS PRC SETC	POK	217,15	0,00	2
Reactive	Schrank im Duschraum defekt	20/10/2014			TECO GMPS NMAT PRC SETC	MATR POK	171,00	171,00	
Preventive	Label Samebox beim Aschneideteich	10/07/2015	09/09/2015		CLSD PCNF PRT NMAT PRC SETC	MATR POK	0,06	0,00	
Reactive	E-Building Ext Lampe defekt	28/09/2015	28/09/2015		TECO PCNF PRT NMAT PRC SETC	MATR POK	190,20	0,00	
Reactive	Heizung von New Office Building defekt	19/08/2014	20/08/2014		CLSD PCNF GMPS PRRT PRC SETC	POK	769,19	0,00	
Reactive	Typar Hauptgang Lampe defekt	02/09/2015	02/09/2015		CLSD PCNF GMPS MSPT PRRT PRC SETC	MATR POK	875,20	0,00	
Other	W-LT54 Rolltore	15/01/2015	21/01/2015		TECO PCNF GMPS NMAT PRRT PRC SETC	MATR POK	3.455,13	1.806,71	24
Reactive	Exit Lampen defekt	11/08/2015	12/08/2015		CLSD PCNF PRT GMPS MSPT PRC SETC	MATR POK	737,22	0,00	42
Other	RSM Typar Visualisation Projekt	28/11/2014	28/11/2014		REL PCNF PRT GMPS MACH PRC SETC	MATR POK	17.799,31	3.417,12	2,46
Reactive	Typar Streuung/Gelcheln RZder aufpumpen	26/01/2015	26/01/2015		CLSD PCNF PRT NMAT PRC SETC	MATR POK	63,40	0,00	
Reactive	Oelanalysesets kaufen	02/09/2015			TECO GMPS PRC SETC	MATR POK	3.471,00	0,00	3,47
Reactive	Notbeleuchtung NR 4 - 106 defekt	03/08/2015	03/08/2015		CLSD PCNF GMPS MACH PRRT PRC SETC	MATR POK	199,59	0,00	7
Reactive	LRT Tr in Oil Shop	02/02/2015			CLSD PRT NMAT PRC SETC	POK	0,00	0,00	
Reactive	UPS Anlage L'fertausch / Update	03/11/2014	19/06/2015		TECO PCNF GMPS PRRT PRC SETC	POK	4.685,42	3.614,00	18
Reactive	Interphone Chipperraum	22/01/2015	23/01/2015	26/01/2015	CLSD CNF PRT NMAT PRC SETC	MATR POK	128,80	0,00	26
Reactive	Exitlampen defekt	09/02/2015	10/02/2015		CLSD PCNF GMPS MACH PRRT PRC SETC	MATR POK	770,37	0,00	28
Reactive	Treppenhaus Beleuchtung	07/05/2015	12/05/2015		CLSD PCNF GMPS MACH PRRT PRC SETC	MATR POK	290,21	0,00	3
Preventive	Notleuchten HTT Raum	10/08/2015	11/08/2015		CLSD PCNF PRT NMAT PRC SETC	MATR POK	126,80	0,00	
Other	To-do Typar - Feste Ropeoffs anbringen	26/01/2015			CLSD PRT GMPS PRC SETC	MATR POK	930,80	0,00	93
Other	W-LT58 Typar O2 Messungen upgrade	19/11/2015			REL PRT NMAT PRC SETC	MATR POK	0,00	0,00	



Single Data Report

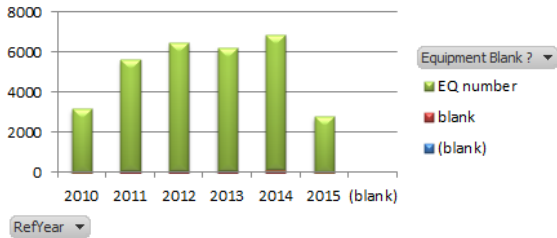
- Compile data from different reports (work orders, costs, hours, etc...)
- Initial Data preparation – predefined data formatting, formulas, calculations



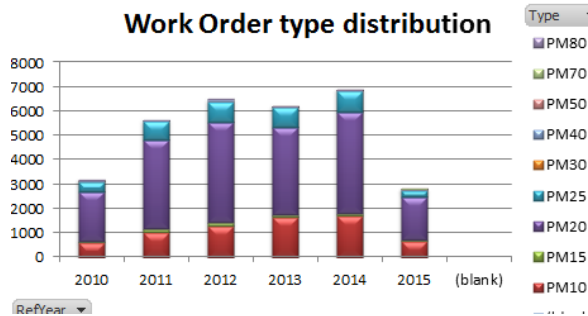
# “Automatize” - Reports

## General Data Overview / Assess Data Quality/ Use of CMMS

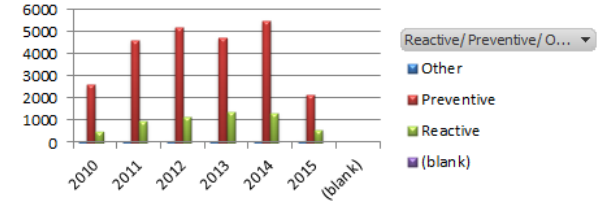
% of work orders created against Equipment Number



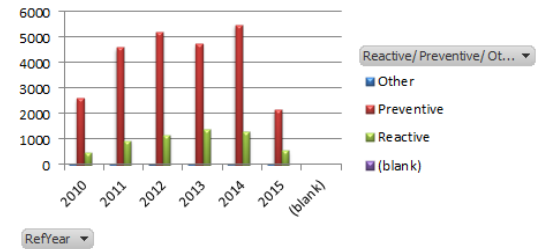
Work Order type distribution



Reactive vs. Proactive - Frequency of work orders

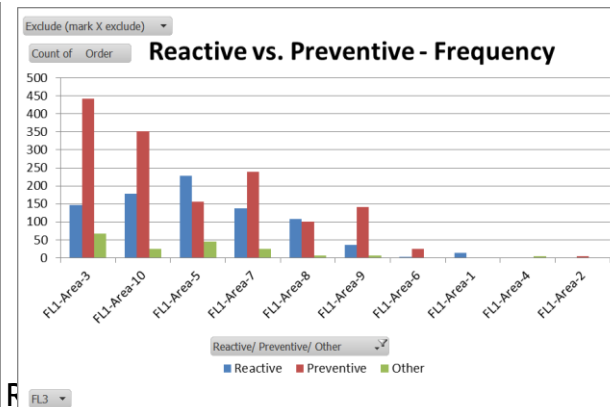
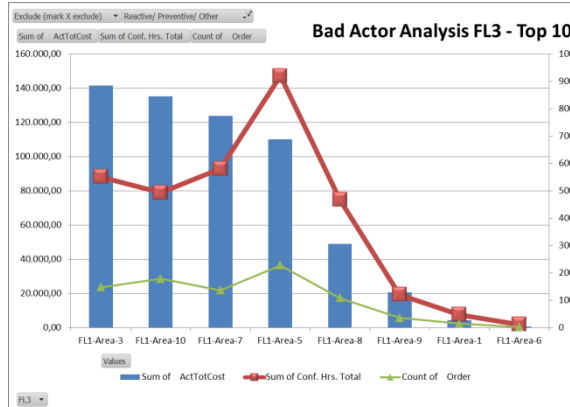


Reactive vs. Proactive - Hours



## Initial Data Analysis – Cost, frequency, hours / Functional Location/Equipment

Row Labels	Sum of ActTotCost	Sum of Conf. Hrs. Total	Count of Order
FL1-Area-3	141.669,95	551,3	147
FL1-Area-10	135.149,80	493,5	179
FL1-Area-7	123.779,16	581	137
FL1-Area-5	110.264,89	920	228
FL1-Area-8	48.982,52	467	108
FL1-Area-9	20.747,58	120,5	36
FL1-Area-1	4.307,91	47,5	14
FL1-Area-6	624,25	12	3
<b>Grand Total</b>	<b>585.526,06</b>	<b>3192,8</b>	<b>852</b>



# Reliability Training

## 3 Day Workshop

- Introduction to Reliability
- Data analysis
- Reliability Tools and Technics
  - Bad Actor, Growth Module, Distributions (Weibull)
- Introduction to 5 Why, RCFA, Kaizen
- Introduction to FMEA
- Introduction to Predictive and Preventive Techniques

## Outcome:

- 4 sessions (2014 and 2015)
- 23 Reliability Practitioners trained in EMEA
- 20 Reliability Practitioners trained in NA
- Reliability Practitioners Network





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- **Results Achieved**
  - Early insights
  - Reliability Network
  - Reliability Improvements Projects
    - Case studies

# Results Achieved



## Early insights:

- Standardised means of reporting on reliability across sites
- Reliability Engineer spends more time on analysing data not gathering and manipulating it
- Focus on improvement for data quality (80/20 rule)
- Better understand of gaps in the work history – engaging the Maintenance and Operations team in the journey
- Promotion and facilitation of increased equipment reliability analysis across DuPont sites. Review of work order history being the foundation for driving continuous improvement in equipment maintenance and reliability

# Reliability Network

*If you want to go fast, go alone.  
If you want to go far,  
Go with others.*

*African Proverb*

Created after the first Reliability Training in 2014.  
Reliability Practitioners from Regional DuPont facilities.



## The Forum to:

- network with Other Reliability Teams
- review the ongoing reliability projects,
- leverage the knowledge,
- develop new ideas, discuss the issues

# Reliability Improvement Projects

Since the Equipment Reliability Enhancement Process was introduced, several reliability improvements projects were accomplished.



## PROJECTS

## BENEFITS (per year)

“Analysis of PPM frequencies for PSM Valves”

➔ 87,000€ Maintenance Cost

“Centrifugal Pumps Reliability Project”

➔ 16,800€ Maintenance Cost  
134,000€ Production Lost

“Driving Unit K2 Feeder Reliability”

➔ 56,000€ Production Lost

“Reduce the Maintenance Cost for Overhaul of U3 Plate and Cutter Knifes ”

➔ 22,000€ Maintenance Cost  
71,000€ Production Lost

# Analysis of PPM frequencies for PSM Valves

## Background

Due to lack of experience at plant startup and insufficient data for the usage conditions, the inspection interval for the PSM valves was set to 1 year, following S23G

Over the time the data was gathered and analyzed. The analysis based on 5 years history: 2010-2015 indicates that there is an opportunity to optimize the inspection strategy, extend the interval between the inspections to meet the availability goal and reduce the maintenance cost.

## Summary - Action

The population was divided in the 3 groups:

- Good Actors - the interval could be extended,
- Medium - MTBF equals 1year
- Bad Actors - the MTBF less than 1 year → RCFA

MOC process to extend intervals - Completed

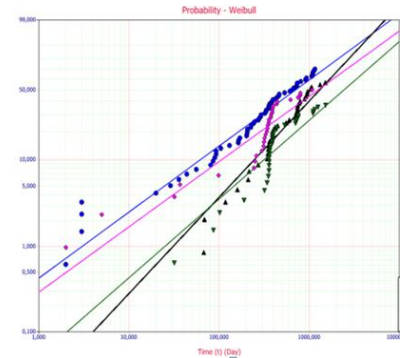
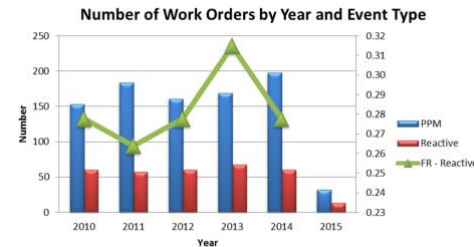
- 80% of the population - extend PPM interval

Failure modes investigated for bad actors (10%)

- Root Cause identified and Actions taken for further

## Analysis

The work history - preventive and reactive work - analyzed.  
The average MTBF ~ 3 years,  
Weibull Analysis - probability of the failure at the given time(t)



## Benefits

The optimization of the Inspection Strategy will result in:

- Increase uptime** - by improving the MTBF for Bad Actor Population
- Reduce Turnaround duration**
- PPM cost savings** - by adjusting the Inspection Interval **86.708 Euro/year**



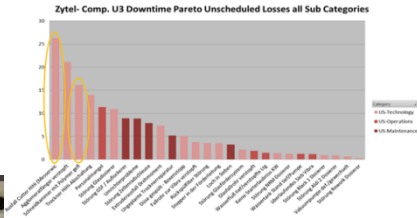
# “Reduce the Maintenance Cost for Overhaul of U3 Plate and Cutter Knives”

## Background

The business objective was to improve the uptime and decrease the Maintenance Cost. The «Bad Actor» Analysis revealed that the Cutting Area should be investigate - high cost, high downtime hours.

Components were responsible:

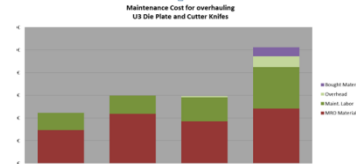
- Cutter Knives
- U3 Die Plate



## Analysis

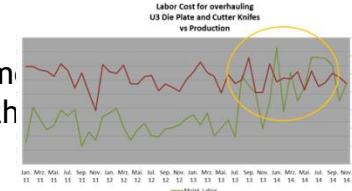
### Cost / Work Orders Analysis

Cutter Problems increase in the same proportion as Maintenance Cost.



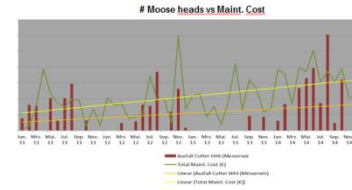
### RCFA Study:

The from the die plate outflowing Polymer strands are wrap around the knife and the complete cutting unit and water box is clogged.



### Reasons:

- Low viscosity in liquid Polymer strands
- Uneven running of the Cutter Knife



## Summary - Action

### Actions:

- Ensure a uniform viscosity of the Polymer
- Ensure a uniform running of the Cutter Knife
- Use the Knives a second time
- improve wear protection of the knife seat



## Benefits

Introduced Improvements programs resulted in:

- Maintenance Cost** for overhauling U3 Die Plate and Cutter Knives in 2015 : **21.832 €**
- Increase Uptime** in 2015: **71.000 €**

# Authors



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*The miracles of science™*