

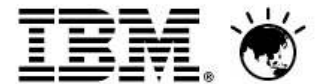
**Pulse**

IBM SolutionsConnect 2013

# Predictive Asset Optimisation for Maximo

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*June 2013*





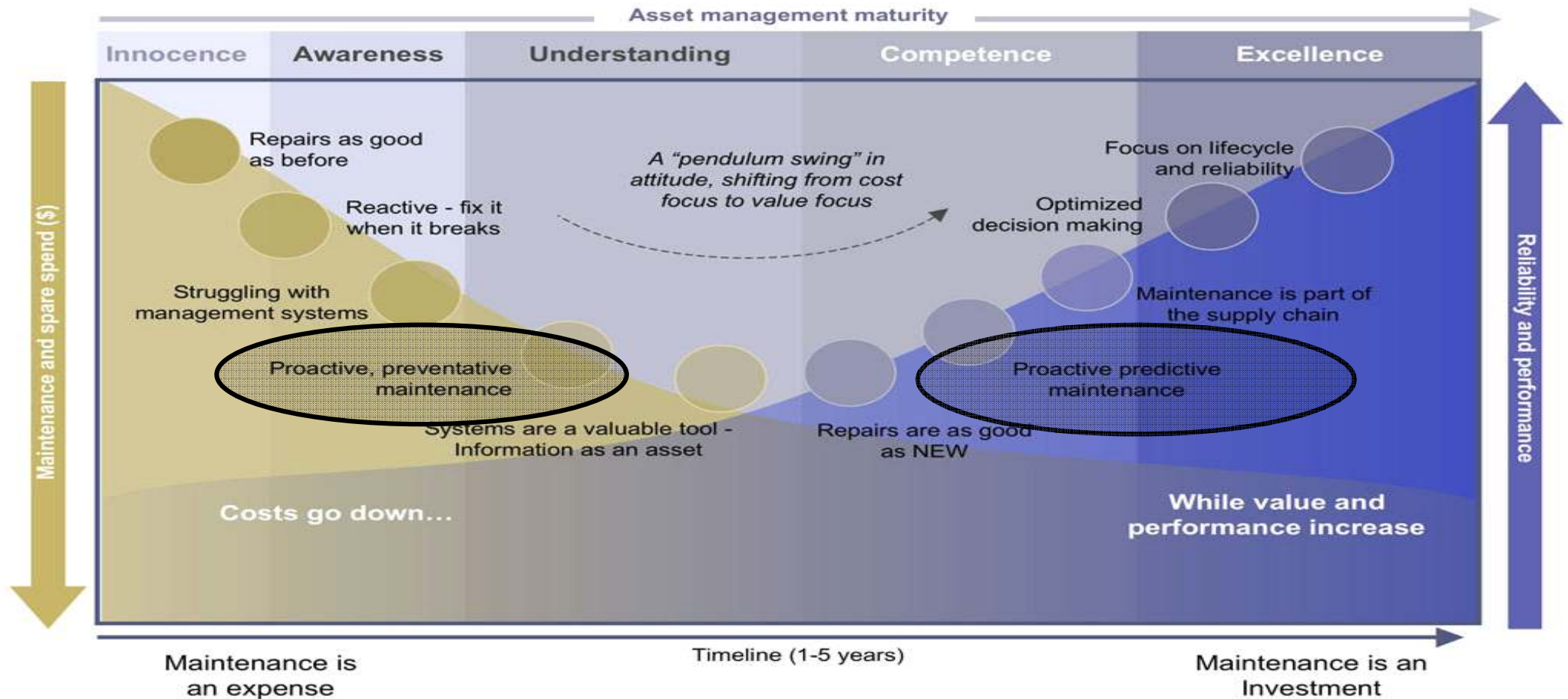
## Gaining Insight from Data



- Analyse patterns found in historical and current transaction data as well as attitudinal survey and social media data to enable better **business discovery and insight** for decision makers and **predict potential future outcomes** or next best action.

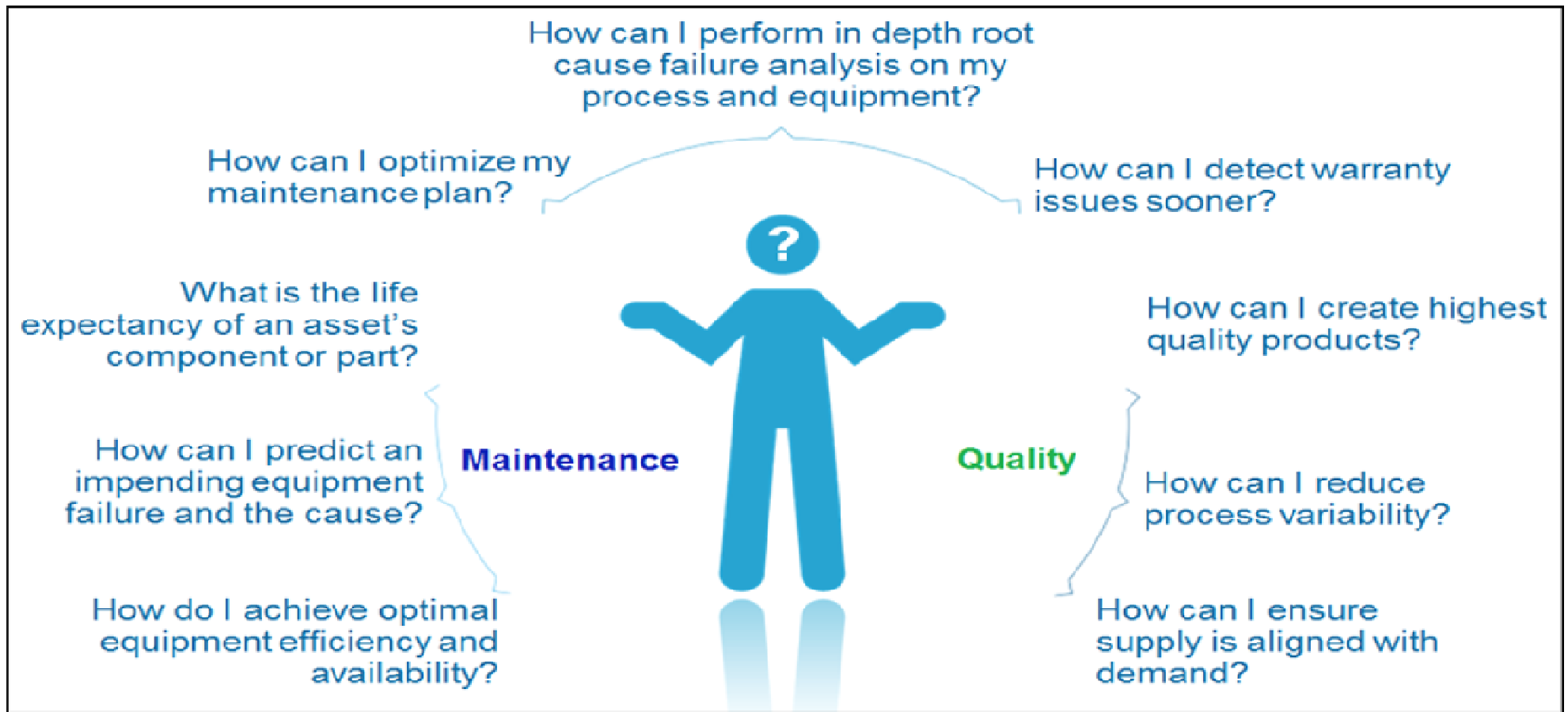


# Asset Management Maturity





# How do we answer these Questions...





# IBM Predictive Maintenance

“A proactive analysis process using equipment and application data from multiple sources to make informed operational, maintenance, repair or component replacement decisions.”

- Forward visibility into equipment, process and quality performance
- Understand, monitor, predict and control process variability
- Enhance equipment and process diagnostics capabilities
- Optimize maintenance intervals
- Minimize unscheduled maintenance
- Enable in depth root cause failure analysis
- Determine optimum corrective action procedures

## **Deliver High Operational Efficiency**

by leveraging multiple (near)  
real-time and historic data-  
sources with advanced  
analytics

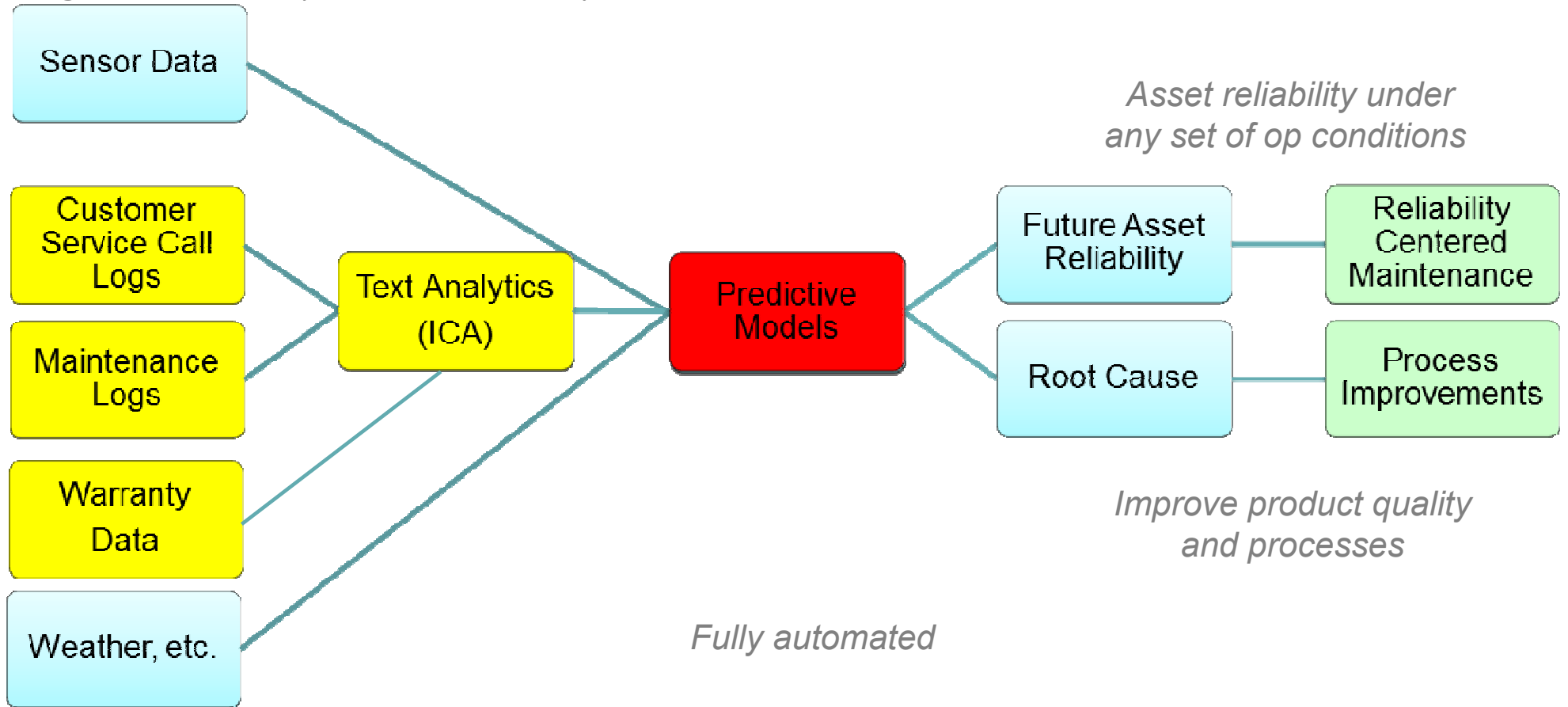






# Smarter Processes driven by Insight

*Leverage all available (even unstructured)*



# Text Mining of Maintenance Reports

**Category**

Category	Descriptors	Docs	Score	Display
All Documents			5549	
Uncategorized		277		
No concepts extracted		8		
location		570	754	
hazard		337	1815	
structure		240	791	
housing		189	577	
transportation		175	463	
risk		131	1391	
drain		120	2445	
report		114	981	
place of business		101	184	
costs		86	1523	
hydrology		83	291	
sewer		81	521	
customer		163	2767	
engineering design		61	132	
natural resources		54	122	
council		50	255	
garden		49	896	
toilet		44	1446	
human resources		42	257	
area		33	164	

**Extract**

Concept	In	Global	Docs	UnitType
2007/05/13		8 (0%)	8 (0%)	<Date>
05/05/07		8 (0%)	8 (0%)	<Date>
treatment		7 (0%)	7 (0%)	<Unknown>
tds		7 (0%)	7 (0%)	<Unknown>
swc		10 (0%)	7 (0%)	<Unknown>
surface water		8 (0%)	7 (0%)	<Unknown>
strong sewage smell		7 (0%)	7 (0%)	<Unknown>
steps		7 (0%)	7 (0%)	<Unknown>
sewer pipe		7 (0%)	7 (0%)	<Unknown>
sepa reporting sewage		7 (0%)	7 (0%)	<Unknown>
semi-detached property		7 (0%)	7 (0%)	<Unknown>
rodding eye		9 (0%)	7 (0%)	<Unknown>
road outside		7 (0%)	7 (0%)	<Unknown>
return		8 (0%)	7 (0%)	<Unknown>
report sewage backing		7 (0%)	7 (0%)	<Unknown>
reoccured		7 (0%)	7 (0%)	<Unknown>
record		7 (0%)	7 (0%)	<Unknown>
receipt of claim		7 (0%)	7 (0%)	<Unknown>
puddle		7 (0%)	7 (0%)	<Unknown>
pub		8 (0%)	7 (0%)	<Unknown>
process		7 (0%)	7 (0%)	<Unknown>
prob		8 (0%)	7 (0%)	<Unknown>
primary school		7 (0%)	7 (0%)	<Unknown>

**Network Diagram**

Nodes: drain, drain/gully/drain, health/public health/sewer/gas/smell of sewage, health/public health/sewer/gas, city/utilities/gas, room/roomsmell, architecture/supporting structure/prop, health/public health/sewer/gas/sewage, architecture/for/basement, backing, customer/cust, economics/property, report, drainage/outside, housing/flats, architecture/structure/blocking, steps.

Legend: Docs (1-7), Shared Docs (1.0-2.0)

**Comments and Categories**

Comment	Categories
1. CUST ADVISES THAT SEWER ON STREET HAS A <b>STRONG SEWAGE SMELL</b> AND HAS GOT STRONGER AND STRONGER OVER THE LAST FEW WEEKS. CAN WE PLEASE ATTEND TO INVESTIGATE	customer/cust health/public health/sewer
2. CUST ADVISES THAT TOILET FACILYS ARE BACKING UP AND <b>STRONG SMELL SEWAGE</b> COMING UP AND IN TO MAIN RECEPTION. WE HAVE ATTEND A FEW TIMES TO THIS LOCATION. WE BELIVE IT IS FLATS ABOVE BLOCKING MAIN SEW...	customer/cust health/public health/sewer architecture/structur... backing housing/flats
3. CUST CALLED IN TO REPORT A <b>STRONG SEWAGE SMELL</b> WITHIN THE PROPERTY. CUST ADVISES IT COMES UP FROM THE BASEMENT. CUST ADVISES THAT THERE IS NO SIGN OF SEWAGE COMING UP FROM ANY DRAIN OUTSIDE OR IN. CU...	health/public health/sewer customer/cust health/public health/sewer architecture/for/bas... drainage/outside economics/property report
4. very <b>strong sewage smell</b> from manholes. this smell so strong, the gas board were out for possible gas leak. please attend.	health/public health/sewer city/utilities/gas room/roomsmell health/public health/sewer

- Text mining produces *structured data*



## GIS Mapping overlay







# Scenario 1: Operations manager





# Alert Management



Machine Failure

Part Failure



! Greenfield Plant

! Line 1

! CNC\_007

✓ CNC\_010

! CNC\_011

✓ CNC\_018

! CNC\_020

! CNC\_025

! CNC\_026

! Line 2

! Line 3

! Line 4

! Line 5

✓ Line 6

! Line 7

! Line 8

Machine	Probable Failure	Action	To be Attended by
CNC_007	Drill Bit Issue	Refit Mislocated Member	Level 1 - Tehcnican
CNC_010	No action	No action	No action
CNC_011	Robotic Arm Malfunction	Tighten Lead Screw	Level 2 - Engineers
CNC_018	No action	No action	No action
CNC_020	Robotic Arm Malfunction	Tighten Lead Screw	Level 2 - Engineers
CNC_025	Drill Bit Issue	Refit Mislocated Member	Level 1 - Tehcnican
CNC_026	Drill Bit Issue	Use Correct Drill Bit for the material	Level 1 - Tehcnican



# Predictive Maintenance Dashboard





# Scenario Modeling

Name	State	Ownership	Reviewer	Last Data Commit
<a href="#">Central Store</a>	Not Started	None	ADMIN	Never committed
<a href="#">Needham</a>	Work In Progress	Admin	ADMIN	Never committed
<a href="#">Information Services</a>	Not Started	None	ADMIN	Never committed
<a href="#">Packaging</a>	Not Started	None		
<a href="#">Garage Store</a>	Not Started	None		
<a href="#">Research and Development</a>	Not Started	None		
<a href="#">Human Resources</a>	Not Started	None		
<a href="#">Sales and Marketing</a>	Not Started	None		

	Jan	Feb	Mar	Apr	May	Jun	Jul
Sales	134,400	134,400	134,400	174,731	188,172	201,613	215,054
Cost of goods sold	45,400	45,400	45,400	136,455	227,424	72,776	97,034
Gross Profit	88,900	88,900	88,900	38,277	(39,252)	128,837	118,019
Gross Profit %	66%	66%	66%				
Salaries	10,000	10,000	10,000				
Depreciation	27,000	27,000	27,000				
Maintenance	4,235	385	385				
Other Costs	41,242	47,400	67,400				
Net Profit	47,682	9,480	(88,060)				
Net Profit %	35%	6%	-55%				

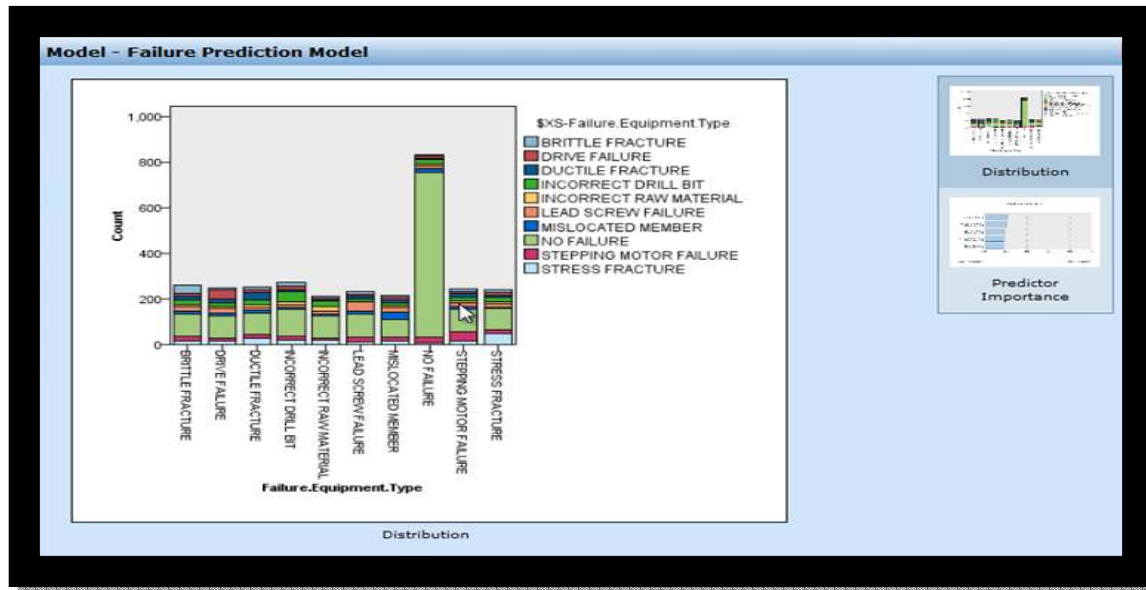
Rows: PnL [PnL] Columns: Months [Months]

Context menu options: Copy, Paste, Data Spread, Holds, Drill, Proportional Spread..., Equal Spread..., Repeat..., Clear..., Percent Change..., Straight Line..., Growth %..., Relative Proportional Spread..., Relative Percent Adjustment..., Repeat Leaves..., Equal Spread Leaves...

- What if analysis
- Workflow
- Security
- Collaborative
- Contribution model

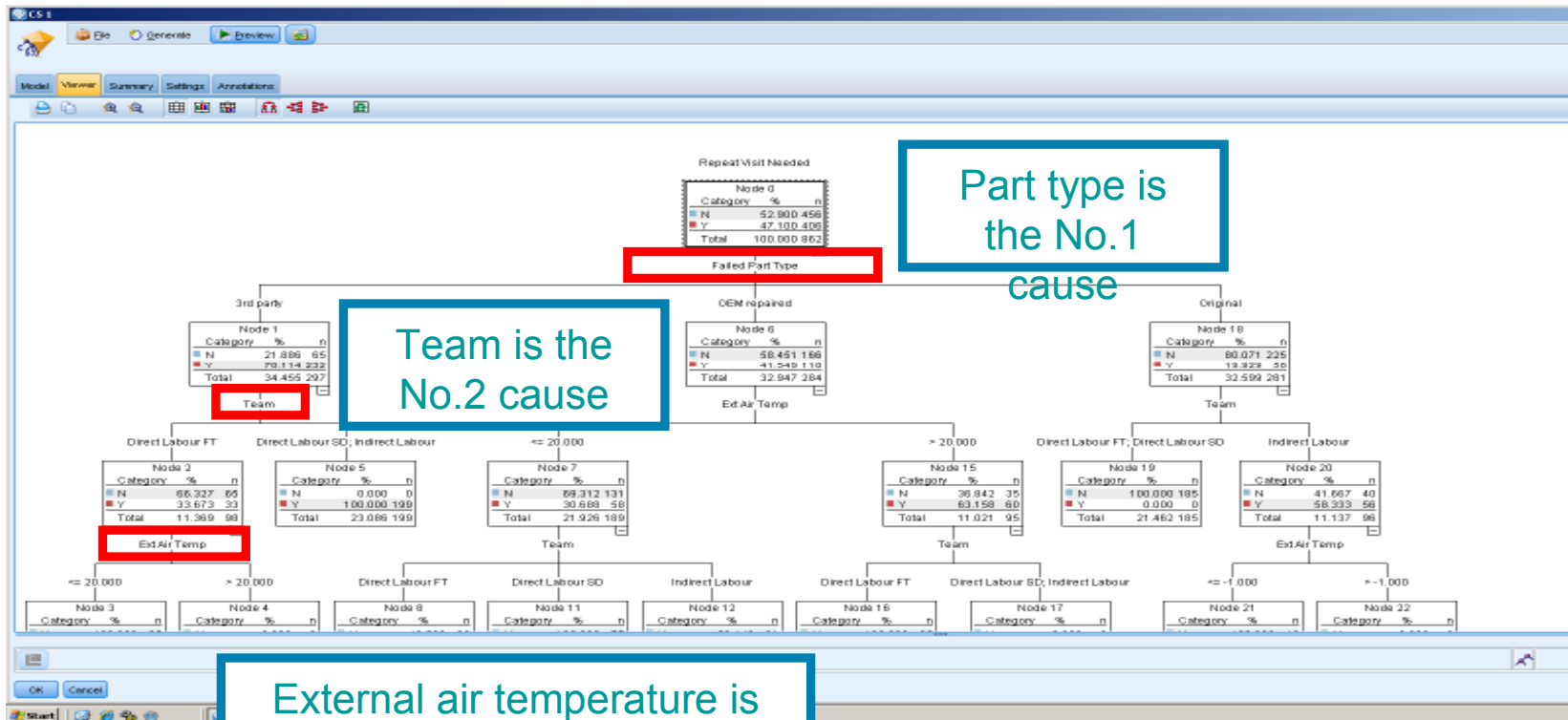


# Scenario 2: Production Manager





# Root Cause Analysis



External air temperature is the No.3 cause – this data came from an external system

Lock project (other users will be unable to edit)

Predictive Maintenance usi...

Hide Define tab from non-administrators

Lock all Define opti

Usecase ServiceGroup

Interaction Points

Search Dimensions:

- Robotic Arm Malfunction
  - Replace Fractured Part
  - Tighten Lead Screw
  - Check Stepping Motor
  - Check Drivers
  - Perform Maintenance
- Drill Bit Issue
  - Refit Mislocated Member
  - Use Correct Drill Bit for the material
  - Use Correct Raw Material for processing

Properties of Robotic Arm Malfunction

Choose Who This Usecase Applies to

	Rule name	Include/Exclu...	Remove
1	<input checked="" type="checkbox"/> Failure codes in Log Failure.Equipment.Type != 0	Include	<input type="checkbox"/>
2	<input checked="" type="checkbox"/> Predicted Faiilures from Log Data Failure Prediction Model(\$XS-Failure.Equipment.Type - Outcor	Include	<input type="checkbox"/>

Allocate Using Segment Rules

Allocate using rules  Multiple Allocation  Allocate randomly

Allocate to: All Match Rules

	Rule name	Allocation	Insert rule	Remove
1	<input checked="" type="checkbox"/> Fractured parts or parts predicted to fail	Replace Fractured Part; Perform	<input type="checkbox"/>	<input type="checkbox"/>
2	<input checked="" type="checkbox"/> Low rotor speed	Tighten Lead Screw; Check Step	<input type="checkbox"/>	<input type="checkbox"/>
3	<input checked="" type="checkbox"/> High voltage	Replace Fractured Part; Perform	<input type="checkbox"/>	<input type="checkbox"/>
4	<input checked="" type="checkbox"/> Predicted driver failure	Check Drivers	<input type="checkbox"/>	<input type="checkbox"/>
5	<input checked="" type="checkbox"/> Time since last service above threshold	Check Drivers; Perform Mainten	<input type="checkbox"/>	<input type="checkbox"/>
6	Remainder	Perform Maintenance		

Simulate  
Test

Lock project

Hide Define

Usecase

Search Dimension

Robotic Arm Me

Replace Fract

Tighten Lead

Check Steppin

Check Drivers

Perform Maint

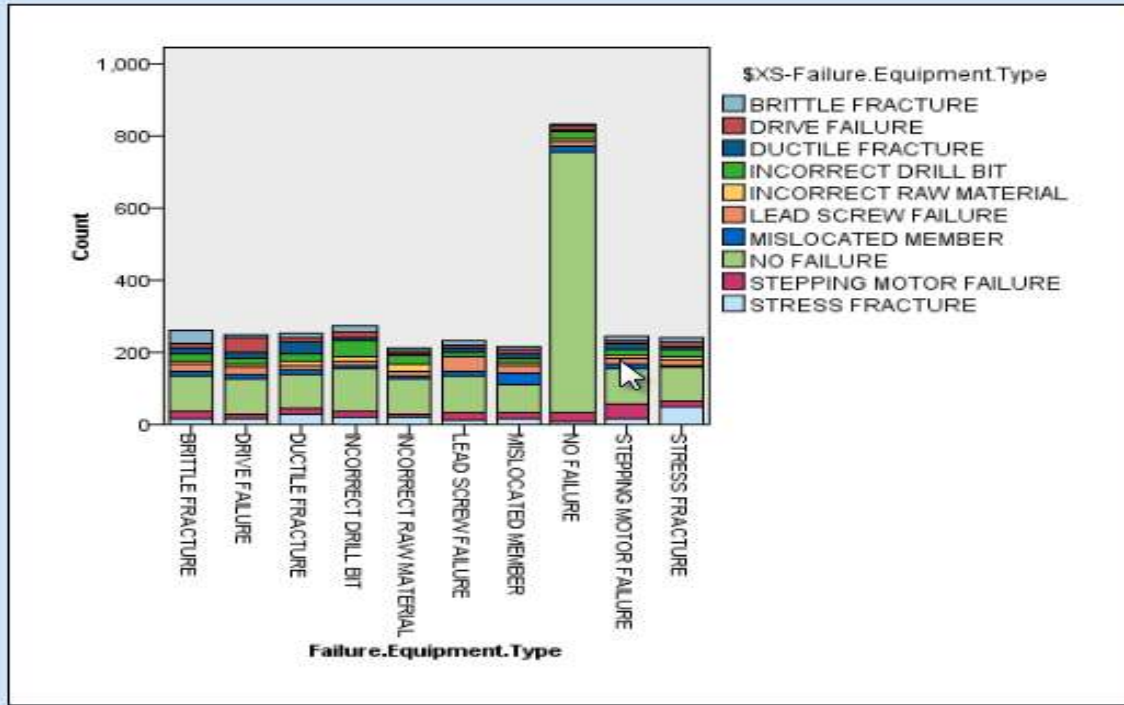
Drill Bit Issue

Refit Mislocat

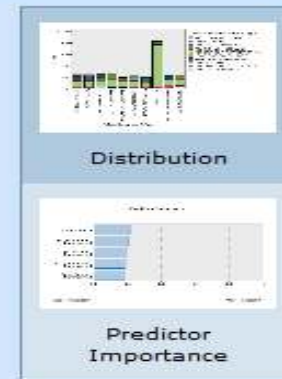
Use Correct Dr

Use Correct R

### Model - Failure Prediction Model



Distribution



Define options

Simulate

Test

Use Model

Exit

Lock project (other users will be unable to edit)

Predictive Maintenance usi...



Hide Define tab from non-administrators

Lock all Define opt

Usecase **ServiceGroup**

Interaction Points



Properties of Level 1 - Technician

Simulate

Search Dimensions:

Test

Choose Who This ServiceGroup Applies to



- Level 1 - Technician
- Level 2 - Engineers
- Level 3 - Expert Engineers

	Rule name	Include/Ex
1	<input checked="" type="checkbox"/> Selected Drill Bit Issues	Include
2	<input checked="" type="checkbox"/> Regular Maintenance in Robotic Arm Malfunction Action = Perform Maintenance Action = Tighten Lead Screw	Include



Lock project (other users will be unable to edit)

Predictive Maintenance usi...



Hide Optimize tab from non-administrators

Lock all Optimize options

WhatIf?...

**Optimization Parameters**

Total Budget:  Max. Actions:  Recent Actions:

Usecase ServiceGroup [Customize table](#)

Usecase/Action	Prob. of Failure	Revenue Impact	Action Cost	Actions Available	Priority	Order
<input checked="" type="checkbox"/> Robotic Arm Malfunction	<input type="text" value="Failure Pred"/>	<input type="text" value="Revenue Irr"/>				
Replace Fractured Part	<input style="background-color: #ffffcc;" type="text" value="Failure Pre..."/>	<input style="background-color: #ffffcc;" type="text" value="Revenue Imp..."/>	<input type="text" value="80"/>	<input type="text" value="10"/>	<input type="text" value="High"/>	
Tighten Lead Screw	<input style="background-color: #ffffcc;" type="text" value="Failure Pre..."/>	<input style="background-color: #ffffcc;" type="text" value="Revenue Imp..."/>	<input type="text" value="50"/>	<input type="text" value="20"/>	<input type="text" value="Normal"/>	
Check Stepping Motor	<input style="background-color: #ffffcc;" type="text" value="Failure Pre..."/>	<input style="background-color: #ffffcc;" type="text" value="Revenue Imp..."/>	<input type="text" value="15"/>	<input type="text" value="20"/>	<input type="text" value="Normal"/>	
Check Drivers	<input style="background-color: #ffffcc;" type="text" value="Failure Pre..."/>	<input style="background-color: #ffffcc;" type="text" value="Revenue Imp..."/>	<input type="text" value="80"/>	<input type="text" value="10"/>	<input type="text" value="Normal"/>	
Perform Maintenance	<input style="background-color: #ffffcc;" type="text" value="Failure Pre..."/>	<input style="background-color: #ffffcc;" type="text" value="Revenue Imp..."/>	<input type="text" value="100"/>	<input type="text" value="10"/>	<input type="text" value="Normal"/>	
<input checked="" type="checkbox"/> Drill Bit Issue	<input type="text" value="Failure Pred"/>	<input type="text" value="Revenue Irr"/>				

**Optimization Model (Value to be maximized)**

[Select equation](#)

( Prob. of Failure  Revenue Impact ) - ( Action Cost  Service engineering group Cost )

**Constraints**

[Select Constraints](#)

Constraint Description	Constraint Value Name
How many actions of this type can be made across all machines	Actions Available
Total Hours available from the service engineering groups	Total Budget



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Predictive Maintenance usi...

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Lock all Optimize opti

**Optimization Parameters**

WhatIf?...

**WhatIf?**

**Simulation Data Source**

Machine Log Data

**Simulation Date**

From: 2012-06-07 22:01:52

15

No expiration

To:

15

**Optimization Parameters**

Total Budget: 15000

Max. Actions: 1

Recent Actions: 0

Usecase

**ServiceGroup**

ServiceGroup	Capacity	Service engineering group Cost
Level 1 - Technician	40	100
Level 2 - Engineers	30	150
Level 3 - Expert Engineers	20	200

**Report Settings**

Name: Run 2

Run

**WhatIf Results**

View All results

<input checked="" type="checkbox"/> Robotic Arm Malfunction	Failure Pred ↓	Revenue Irr ↓
<input checked="" type="checkbox"/> Drill Bit Issue	Failure Pred ↓	Revenue Irr ↓

**Report Settings**

Name:  Run

**WhatIf Results**

View  All results  All runs

**Usecase** **ServiceGroup**

Display  ↓

Number of runs retained: 2

Action	Count	Budget Spent	Expected profit
<input checked="" type="checkbox"/> Drill Bit Issue	26	4260	50106.8
Refit Mislocated Member	6	1560	7305.4
Use Correct Drill Bit for the material	10	1300	24090.9
Use Correct Raw Material for processing	10	1400	18710.6
<input checked="" type="checkbox"/> Robotic Arm Malfunction	50	10680	103270.2
Replace Fractured Part	10	2800	21643.8
Tighten Lead Screw	18	3900	34149.2
Check Stepping Motor	20	3500	44465.1
Check Drivers	1	230	1966
<b>Total</b>	<b>76</b>	<b>14940</b>	<b>153377.1</b>

Total Records: 100

Update Settings

Close

⊕ Robotic Arm Malfunction

⚠ Failure Pred ↓

✎ Revenue Irr ↓

⊕ Drill Bit Issue

⚠ Failure Pred ↓

✎ Revenue Irr ↓

### ▶ Report Settings

Name:

▶ Run

### ▼ WhatIf Results

View  All results  All runs

Usecase

ServiceGroup

[-] [+] Display

Number of runs retained: 2

Action	Run1 <span>✖</span>	Run 2 <span>✖</span>
Level 1 - Technician	23	26
Level 2 - Engineers	20	30
Level 3 - Expert Engineers	10	20
Count	53	76
Budget Spent	9885	14940
Total Channel Cost	7300	11100
Expected profit	142795.4	153377.1

Total Records: 100

Update Settings

Close



# Summary

- **Objective**
  - Maximize cost savings
- **Things you know (rules)**
  - Equipment history and repair schedule
  - What failures have happened in past
  - Cost of repairs / down time
- **Things that are uncertain (models)**
  - What will break next
  - Changes in demand
  - Business environment, physical environment
- **Constraints**
  - Budget
  - Available of technicians, equipment





## The balance between risk & financial saving

What if I push back the maintenance by 1 month?

How much will we save?

How will the risk of failure increase?

When do we predict the asset will fail?

Let's push back by only 2 weeks to get the saving but not risk failure...







# Early Equipment Anomaly Detection

## Komatsu

Exponential growth of the machine population year on year with limited resources to maintain and support existing fleets.

### Results

- 18% decrease in problem identifications to solution
- Implemented proactive monitoring system using multiple parameters from various sources
- Repair procedures incorporated before failure
- ROI 12-14 times in first 4 months

**\$1 Million**  
In the first 2 weeks





# Reduction in Unscheduled Aircraft Downtime (UAD)

## Major US Domestic Airline

Aircraft shortages resulting from unscheduled downtime impact customer arrival times, crew scheduling, revenue and brand reputation

### Results

Pinpoint subsystems which are more important drivers of UAD that warrant special attention.

Provide context and evidence based investment decisions in improvements

A quantifiable improvement in reliability against the additional investment

**Predicting Downtime**  
Keeps flights on time





# Reduction in direct maintenance costs

## Sikorsky - Helicopters

ability to analyze various data types and formats, including structured and unstructured, historical and current to determine the relationship to how the aircraft is being operated and maintained and the consumption of parts

ults

Embed a just-in-time inventory prediction into supply management systems for real-time monitoring and decision making

Identify and predict equipment maintenance for helicopter customers

Intelligently price extended warranty contracts based on up predicted costs and repairs by aircraft.

**Lowest FH Cost**  
**Highest Availability**  
Increased Customer loyalty





# Questions?

