Condition Monitoring

An Important Element of Overall Mining Equipment Management

Tim Siekmann

Caterpillar Global Mining

CATERPILLAR®

A History of Progress

CATERPILLAR®

1925: Holt & Best companies merge into Caterpillar Tractor Co.

1960-1970: Rapid global expansion

2001: Joined World Business Council for Sustainable Development

1925	1930	1940	1950	1960	1970	1980*	1990	2000	2010	2011
$13.8 Million	$45.4 Million	$73.1 Million	$337.3 Million	$716 Million	$2.1 Billion	$8.6 Billion	$11.4 Billion	$20.2 Billion	$42.5 Billion	$60.1 Billion

1931: First diesel track-type tractor

1942: Cat machines serve in World War II

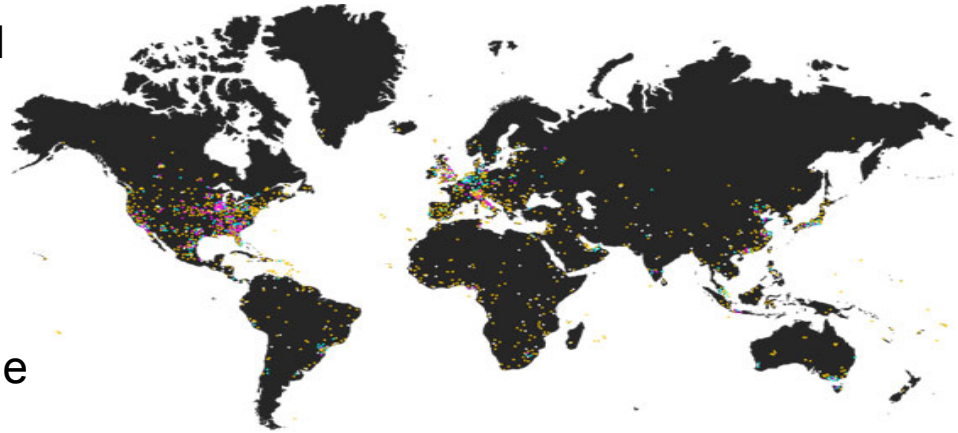
1986: Factory modernization

2011: Acquired Bucyrus International, Inc.

* In 1978, the company began reporting Sales & Revenues

A Global Reach

- Global reach and presence is unmatched in the industry
- Serve customers in more than 180 countries around the globe
- More than half of our sales are outside the United States
- Manufacturing, marketing, logistics, service, R&D and related facilities along with our dealer locations total more than 500 locations worldwide



Dealers

- 188 worldwide with more than 126,000 employees
- Independent, locally owned
- Key competitive advantage

Original Caterpillar Tractor Company Office (circa 1935)

CAT and OSIsoft, a lot in common

A Broad Range of Products and Industries

Cat equipment – more than 3 million pieces globally – is at work for our customers on highways, rail lines, oceans and rivers, in forests, quarries, mine sites and oil fields.

The Next Great Chapter in Mining

Mining Equipment Management

Availability + Component Life + Rebuild Cost = Cost / Hr Cost / Ton

Maintenance & Repair Process

- Preventative Maintenance
- Condition Monitoring
- Planning & Scheduling
- Repair Mgmt
- Component Mgmt
- Backlog Mgmt
- Parts Mgmt
- Training
- Performance Evaluation
- Continuous Improvement

Application Changeable Non-Changeable

- Mine Location
- Pit Design
- Haul Road Conditions
- Truck Loading

Component Life Management

- Component History Mgmt
- Component Database Mgmt
- Component Performance Rpt
  - Product Groups
  - Regions / Dealers
- Unique Component Identifier
- Statistical Life Projection
- Assist CPI Find-it prioritization

Component Renewal

- Repair Management
- Rebuild Mgmt (CRC)
- Salvage Mgmt (Shop)

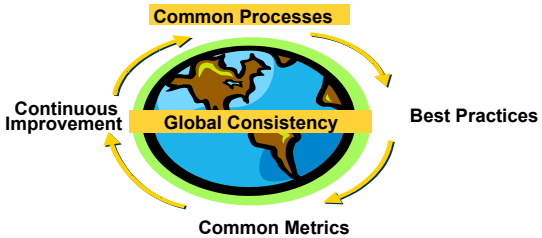
Product Quality & Reliability

- Designed Life
- CPI Issues Fix
- Serviceability
- Parts Commonality
- Failure Reporting

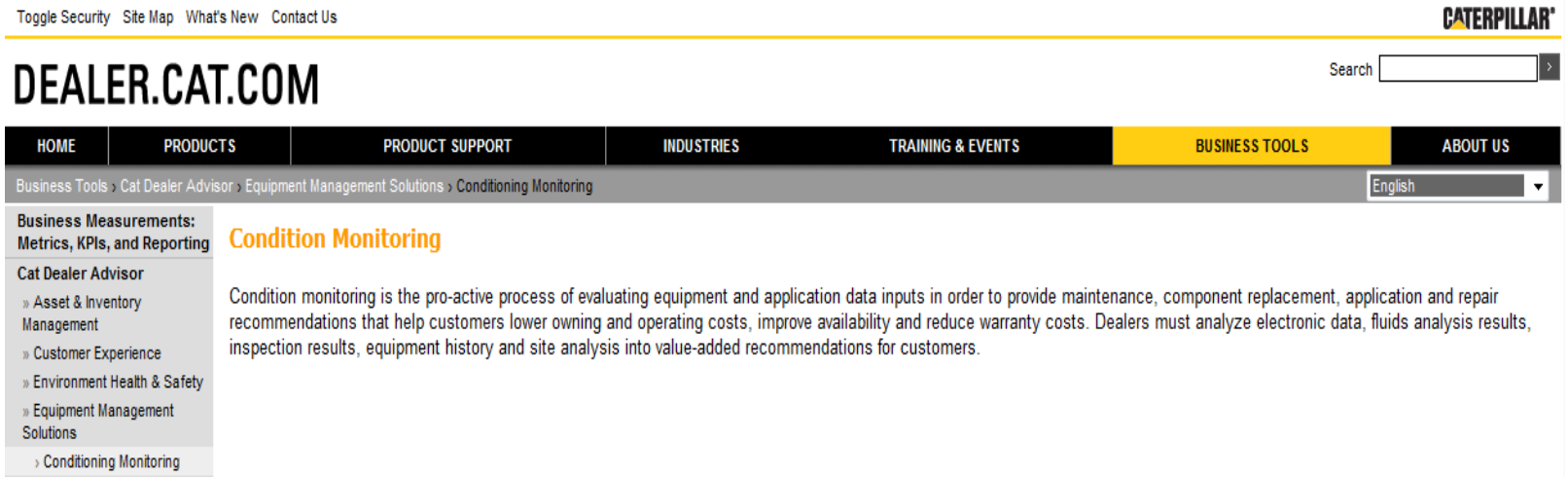
MARC Management

- Market Strategy
- Rate Development
- Risk Analysis & Quantification
- Strategy Development & Implementation
- Financial Management

WHEREVER THERE'S MINING



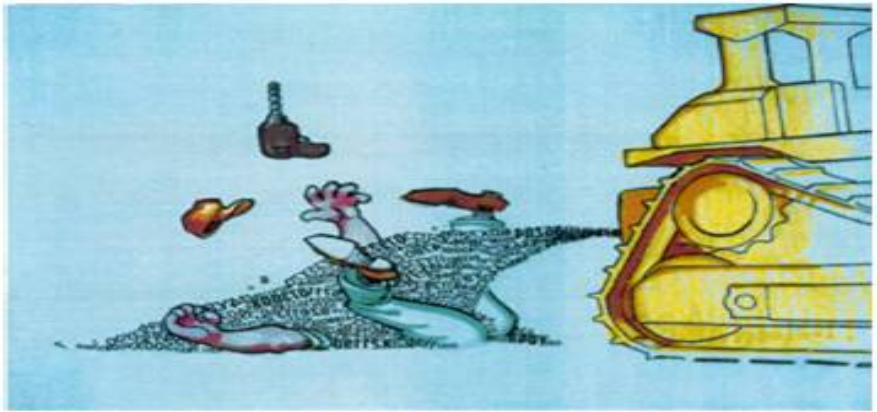
Common Definition

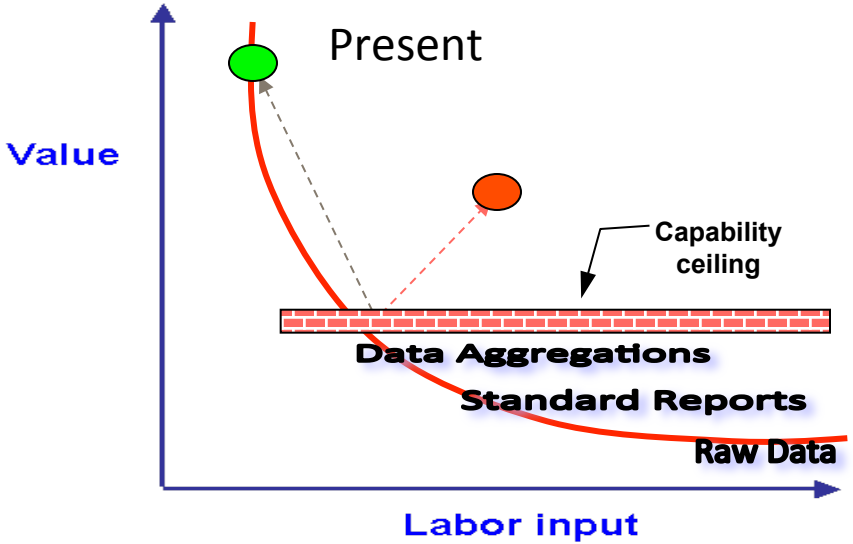


… the proactive process of evaluating equipment and application date inputs in order to provide maintenance, component replacement, application and repair recommendations that help customers lower owning and operating costs, improve availability and reduce warranty costs. Dealers must analyze electronic data, fluid analysis results, inspection results, equipment history and site analysis into value-added recommendations for customers.

Condition Monitoring

Past



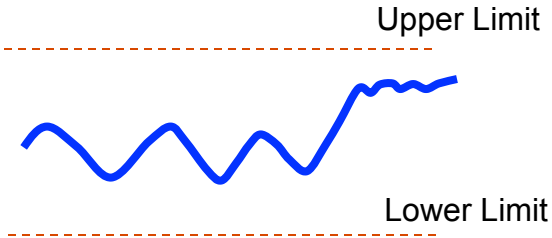


From information overload…….

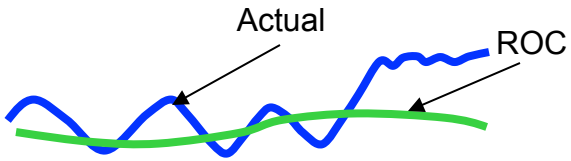
……To actionable intelligence

Machine Compared to a Standard

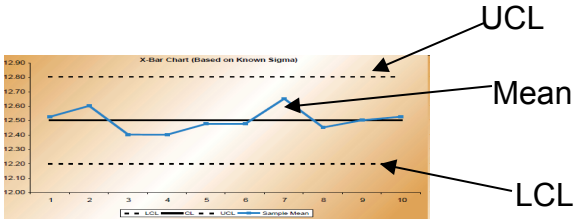
Identify emerging failures based on standard and engineering limit excursions and rates of change in data sources exceeding nominal values



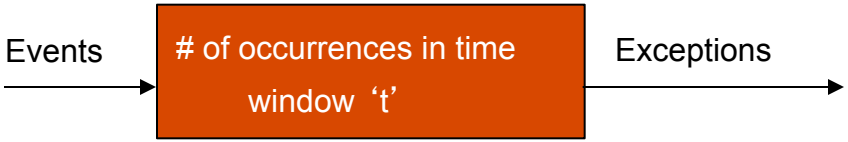
Engineering Limits



Rate Of Change (ROC)



Statistical Quality Control (SQC)



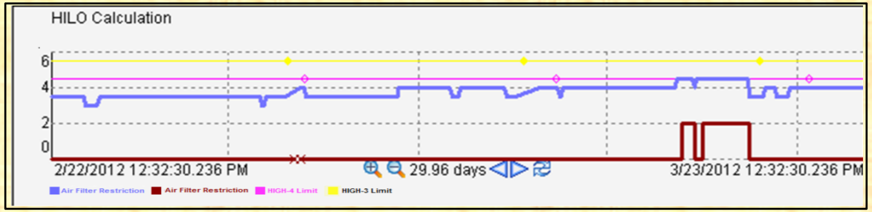
Event Analyzer

Data Used

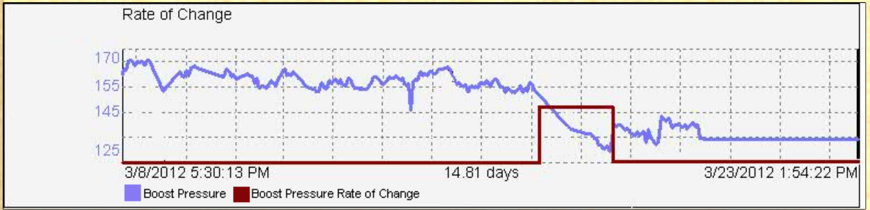
- Trends
- Fluid analysis raw data
- Events (frequency of events)
- Real time streaming data (if available)

Analytical Models

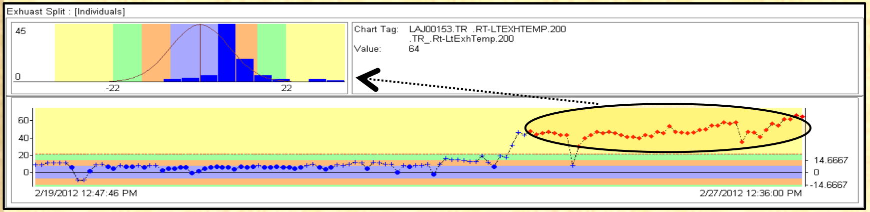
Air Filter Restriction HI/Low Results



Boost Pressure vs Rate Of Change



Exhaust Split Statistical Quality Control Modeling



High-Low Exception Score Card

Wheeler CAT

*-2d	*
3/22/12	3/24/12
Start Date	End Date

Air Filter & Exhaust System

Site	Machine	Most Recent Trends Data	Air Flt Rest - ENG LOADED - Max	AMB AIR TEMP - ENG LOADED - Avg	Boost Pressure, ENG LOADED-Avg	LT EXH TEMP - ENG LOADED - Max	RT EXH TEMP - ENG LOADED - Max	RT-LT EXH TEMP - ENG LOADED - Avg
Quadra Robinson	ATY00770 - HTK262	3/23/12	3.5	8	165	663	638	-20
Quadra Robinson	ATY00771 - HTK263	3/23/12	2.5	9	145	644	678	24
Quadra Robinson	ATY00806 - HTK264	3/23/12	3.5	6	152	683	659	-14
Quadra Robinson	ATY00807 - HTK265	3/24/12	3.5	9	166	641	627	-5
Quadra Robinson	ATY00808 - HTK266	3/23/12	3.0	5	161	650	667	17
Quadra Robinson	ATY00809 - HTK267	3/23/12	3.5	9	167	632	627	-7
Quadra Robinson	ATY00810 - HTK268	3/24/12	3.0	10	167	689	686	2
Quadra Robinson	ATY00823 - HTK269	3/24/12	2.5	10	164	663	631	-14
Quadra Robinson	ATY00824 - HTK270	3/23/12	3.5	9	139	702	754	29
Quadra Robinson	ATY00825 - HTK271	3/23/12	4.0	9	165	676	648	-8
Quadra Robinson	ATY00826 - HTK272	3/17/12	3.5	2	157	632	636	4
Quadra Robinson	ATY00827 - HTK273	3/23/12	3.0		168	668	670	5
Quadra Robinson	ATY00857 - HTK274	3/23/12	3.0	9	164	659	657	7
Quadra Robinson	ATY00858 - HTK275	3/23/12	4.0	10	168	656	625	-10
Quadra Robinson	FDB01301 - HTK276	3/23/12	4.5	11	162	628	629	4
Quadra Robinson	FDB01302 - HTK277	3/23/12	10.0	15	167	644	631	0

Lubrication & Cooling System / Converter

Machine	ENG COOL TEMP - ENG RUNNING - Avg	ENG OIL FLTR - ENG HI & COOL>74 - Max	ENG OIL PRES - ENG LO & COOL>74 - Avg	ENG OIL PRES - ENG HI & COOL>74 - Avg	R Aftclr Temp, Engine Loaded- Max	LCKUP SHFT TIME - DOWNSHIFT GEARS - Avg	LCKUP SHFT TIME - UPSHIFT GEARS - Avg
ATY00770 - HTK262	84	21	368	463	61	1.43	1.16
ATY00771 - HTK263	85	22	358	452	66	1.59	1.44
ATY00806 - HTK264	80	28	380	487	58	1.76	1.81
ATY00807 - HTK265	80	21	390	476	58	1.53	1.50
ATY00808 - HTK266	83	20	377	465	61	1.63	1.60
ATY00809 - HTK267	81	26	360	437	62	1.55	1.32
ATY00810 - HTK268	83	36	179	359	61	1.43	1.21
ATY00823 - HTK269	82	25	361	437	63	2.12	1.79
ATY00824 - HTK270	86	22	349	432	62	1.70	1.49
ATY00825 - HTK271	88	0	366	462	63	1.56	1.34
ATY00826 - HTK272	82	25	327	439	49	1.45	1.18
ATY00827 - HTK273	83	20	369	455	62	1.49	1.22
ATY00857 - HTK274	87	20	373	462	64	1.54	1.30
ATY00858 - HTK275	81	13	350	458	68	1.52	1.29
FDB01301 - HTK276	86	29	343	429	59	1.58	1.28
FDB01302 - HTK277	88	18	334	421	60	1.73	1.39

Brake System

Machine	LT F BRK TEMP - BRAKING - Avg	RT F BRK TEMP - BRAKING - Avg	RTF-LTF BRKTEMP - TRAVELING - Avg	LT R BRK TEMP - BRAKING - Avg	RT R BRK TEMP - BRAKING - Avg	RTR-LTR BRKTEMP - TRAVELING - Avg
ATY00770 - HTK262	80	80	0	88	87	0
ATY00771 - HTK263	82	81	0	91	89	0
ATY00806 - HTK264	78	77	0	87	86	0
ATY00807 - HTK265	81	80	0	83	83	1
ATY00808 - HTK266	81	80	-1	67	86	18
ATY00809 - HTK267	78	75	-2	84	83	0
ATY00810 - HTK268	79	78	0	88	86	-1
ATY00823 - HTK269	83	82	0	91	89	0
ATY00824 - HTK270	83	83	0	91	90	0
ATY00825 - HTK271	84	85	0	95	93	0
ATY00826 - HTK272	76	76	0	84	83	0
ATY00827 - HTK273	78	77	0	86	85	0
ATY00857 - HTK274	83	82	0	91	90	0
ATY00858 - HTK275	85	84	0	92	91	0
FDB01301 - HTK276	76	72	-4	89	88	0
FDB01302 - HTK277	84	80	-5	91	90	0

Suspension / Transmission

Machine	RTF-LTF SUSPCYL - TRAVELING EMPTY - Avg	RTF-LTF SUSPCYL - TRAVELING LOADED - Avg	RTR-LTR SUSPCYL - TRAVELING EMPTY - Avg	RTR-LTR SUSPCYL - TRAVELING LOADED - Avg	SUSP CYL LTF - TRAVELING LOADED - Avg	SUSP CYL LTR - TRAVELING LOADED - Avg	SUSP CYL RTF - TRAVELING LOADED - Avg	SUSP CYL RTR - TRAVELING LOADED - Avg	Transmission slip. 2-3 Avg	Transmission slip. 3-2 Avg	Transmission slip. 3-4 Avg	Transmission slip. 4-5 Avg
ATY00770 - HTK262	-232	459	-384	-2003	5037	11588	5496	9585	0.70	0.82	0.66	0.70
ATY00771 - HTK263	-250	-238	-806	-1361	4420	7783	4790	7325	1.07	0.87	0.86	1.06
ATY00806 - HTK264	5	493	-344	-3634	4949	6935	3702	8228	1.15	1.14	1.03	0.94
ATY00807 - HTK265	-334	-92	-123	-1395	4599	11166	4508	9771	1.04	1.01	0.95	0.83
ATY00808 - HTK266	-123	370	48	1456	4655	10293	5025	11749	1.34	1.05	0.91	0.93
ATY00809 - HTK267	-798	515	-239	-5521	4930	12971	5445	7450	0.64	0.65	0.72	0.67
ATY00810 - HTK268	-522	-1059	178	-927	5453	11067	4394	10140	0.69	0.52	0.53	0.69
ATY00823 - HTK269	-470	-654	289	3948	6239	15225	4884	6487	1.32	1.70	1.34	1.43
ATY00824 - HTK270	-422	618	353	-4612	4304	8259	4604	7287	1.13	1.12	0.96	1.02
ATY00825 - HTK271	-350	-963	897	1896	5661	9946	4698	11843	0.74	0.72	0.86	0.79
ATY00826 - HTK272	-149	-290	121	-2618	5408	10880	5118	8261	0.70	0.53	0.68	0.70
ATY00827 - HTK273	96	421	-3382	-1833	4619	10739	5040	8906	0.81	0.53	0.69	0.85
ATY00857 - HTK274	78	496	-843	-3694	4868	12355	5365	8661	0.77	0.66	0.72	0.80
ATY00858 - HTK275	-1108	-1406	2561	5814	6411	7159	5004	12974	0.86	0.77	0.86	1.11
FDB01301 - HTK276	-541	444	-1344	-9581	4289	15230	4733	5649	0.58	0.68	0.75	0.63
FDB01302 - HTK277	-345	-338	76	-1657	4908	10919	4570	9261	0.74	0.58	0.68	0.75

Email/Notification

Site	CAT Dealer - Site Name
Asset	ATY00XXX- TT100
Incident Start Date:	2/25/2012
Issue	Exh Split- Trending High
Possible Causes	Possible Sensor/Harness issue
	Possible Weak/Dead Injector on Lt side
	Possible Bellow Leak
Questions	Is there any complain about LOW Power?
Action Item	On Next Scheduled service perform Cylinder Cut out Test

Dealer	Site	Machine (Start Date 2/25/12)	Most Recent Trends Data (End Date 2/27/12)	Exhaust System: LT EXH TEMP - ENG LOADED - Max	RT EXH TEMP - ENG LOADED - Max	RT-LT EXH TEMP - ENG LOADED - Avg	LT IMAP - ENG LOADED - Avg	RT IMAP - ENG LOADED - Avg	LT IMAT - ENG LOADED - Max	RT IMAT - ENG LOADED - Max
CAT Dealer	Site	LAJ00XXX- TT100	2/27/12	616.11	691	46.48	229.78	190.68	52.1	40.2

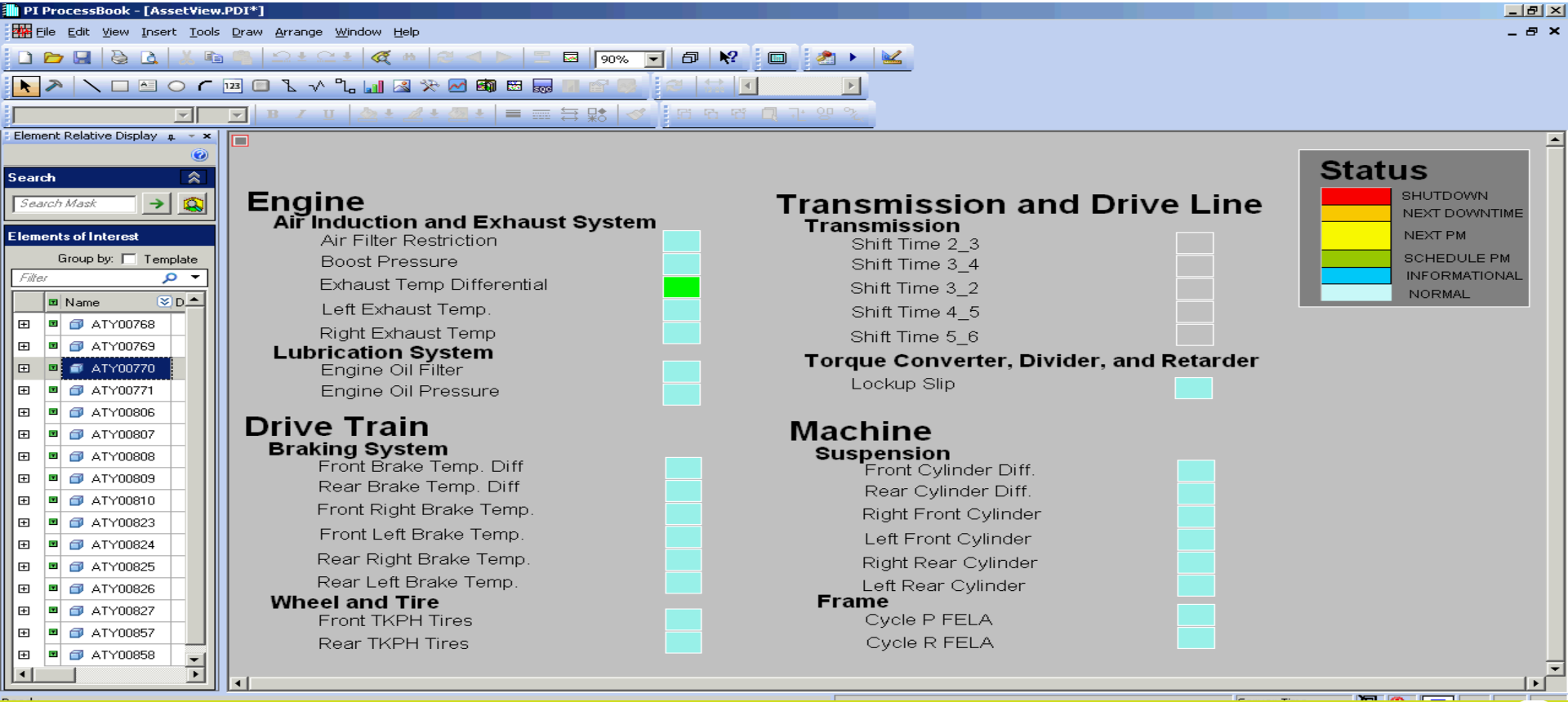
Color Code	Description
Priority 1	Immediate Shutdown
Priority 2	Action Within 24 Hours
Priority 3	Action Within 1 Week
Priority 4	Action In next service
Priority 5	Informational

Trends Data

Events

No of Event Occurred			Description
Event ID/ Dates	**Level 2**	**Grand Total**	
⊟ 7082	**20**	**20**	**High Exhaust Differential Temperature**
2/28/2012	20	20	
Grand Total	**20**	**20**	

An Overview of the Equipment



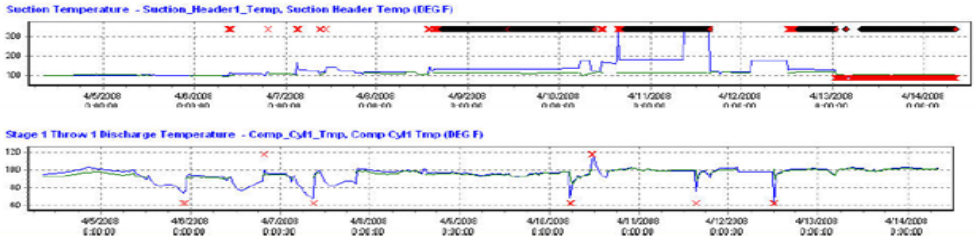
Value of Condition Monitoring……

Benefits for customers….

- Information vs. data
- Less labor to identify repair recommendations
- Better equipment utilization
- Reduced unit operating costs

Benefits for Caterpillar and Dealers…

- Differentiation in the marketplace
- Long-term partnerships with our customers
- Improved understanding of equipment applications



A Winning Partnership

Technology + **Caterpillar Product Knowledge** + **Cat Dealer Service Excellence**

The Right Tools to Manage Data and Rapidly Turn It Into Action

THANK YOU

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