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Predictive Analytics

Business Partner IBM SPSS®

Predictive Operational Analytics

פתרונות אנליטיים מתקדמים לסביבת הייצור והתפעול

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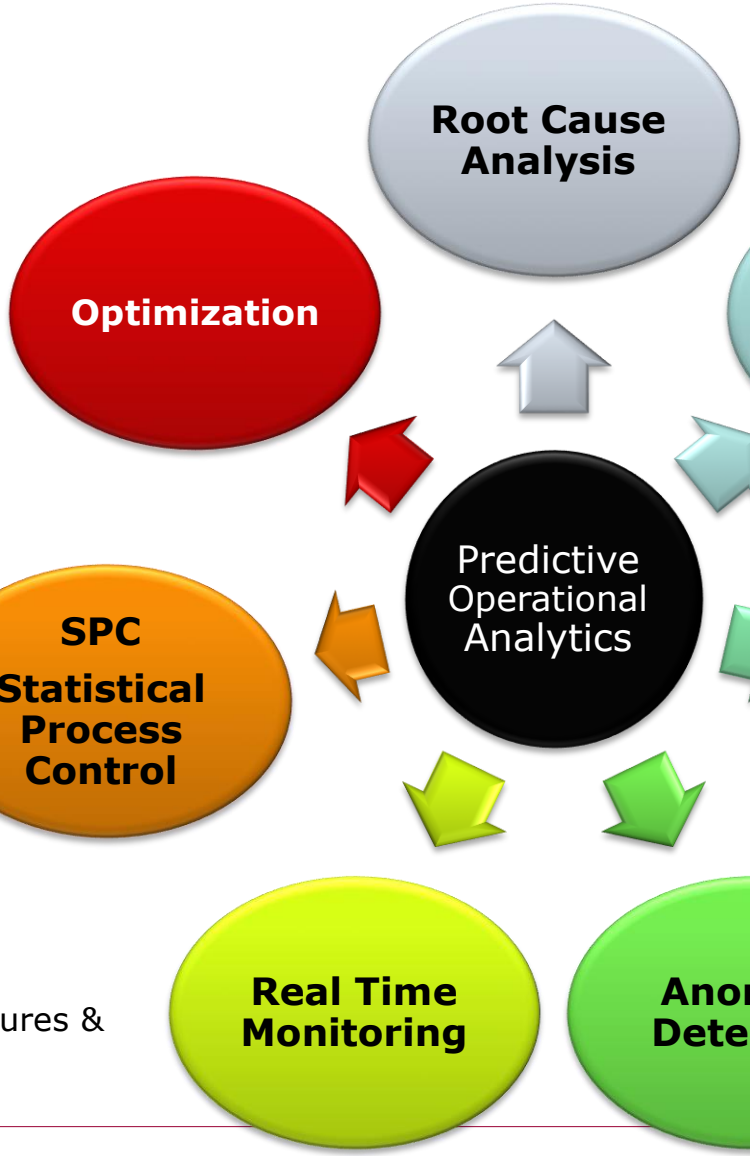
Predictive Operational Analytics Solutions



Post mortem failure analysis, understand causes and identify predicting tags

Early detect failures based on predicting tags

Suggest Proactive Maintenance

Identify abnormal values without defining the norm

Monitor tags predicting failures & anomalies

Monitor and perform QA on tags based on 6 Sigma model

Machines Setup, Processes, Stock, Planning, Unit Commitment

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Predictive Operational Analytics Capabilities

- Failure Root Cause Analysis
- Proactive Maintenance
- Fault Detection
- Anomaly Detection
- Sensor Reliability Analysis
- Stage Transformation Efficiency
- Fuel Consumption Analysis
- Critical KPI's Deviation Detection
- Real Time **SPC** Monitoring
- Rule Violation Control
- Alarms Cascade
- Optimization
  - Machine Setup
  - Production Line Continuity
  - Stock
  - Processes
  - Unit Commitment
- Energy Management
- Chief Clock

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Root Cause Analysis of Turbine Collapse

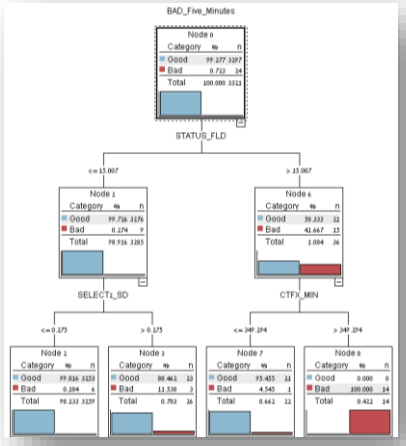
In-depth investigation of inexplicable failures of turbine

Business challenge

Unexplained occasional collapses of gas turbines resulted in costly downtimes and harmed availability of electricity supply.

Solution

IEC turned to IBM SPSS predictive analytics technology in order to identify the root causes of the collapses, hence prevent reoccurrence of such events in the future.
A thorough data analysis revealed differences in the homogeneous dispersion of a certain tag prior to collapses. Further analyses showed that the problem did not occur only before the crash, it occurred also several times in the past.
The turbine configuration parameters have been changed according to the findings of the analysis.



Benefits

- The problem disappeared.
- Team work of analyst, engineer and database manager has proven to be of high added value.

"Using IBM-SPSS's analytical tools has brought to significant savings, both in time of fault understanding and in dollars spent on turbine failures and downtimes."

Dr. Moshe Shavit, Ph.D.
CTO, Gas Turbines, IEC

Solution components

- IBM SPSS Statistics
- IBM SPSS Modeler

Industry

- Utilities

Israel Electric

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Online Statistical Process Control (SPC)

Real time monitoring and analysis of Key Performance Indicators

Business challenge

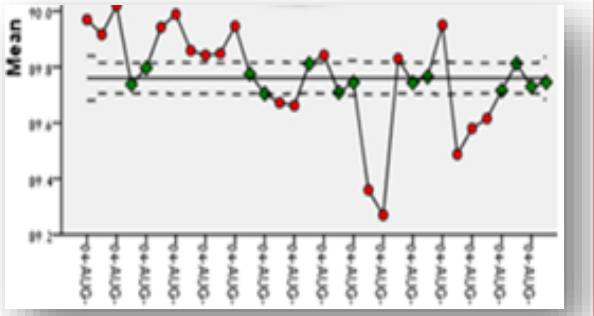
Several Key Performance Indicators (KPIs) of gas turbines' wellness are of high interest for the control engineer. However, these KPIs of temperatures and pressures tend to behave differently, according to unit status. In order to constantly monitor them, it was decided to develop a designated custom-made system.

Solution

A technique known as SPC (Statistical Process Control) was adopted for implementation, mainly due to being both visually comprehendible and statistically proven. Three KPIs were chosen for monitoring, and three time-resolution options were determined: 1, 15 and 60 minutes. The system was deigned such that IBM-SPSS Statistics continuously draws raw data from the operational database, analyses them online using the SPC technique, and produces an HTML output, which in turn is shown on web monitors.

Benefits

- Outlying KPIs are easy to detect.
- With a click of a button, the control engineer can choose site, unit, and work state for the SPC analyses.
- The HTML-based system can be shown on any platform with a web browser, including desktops, laptops, tablets and smartphones, without any software installation.



"This system enables us to remotely (mobile, web …) supervise a variety of KPIs across various units, work phases and time resolutions, in a user-friendly graphical user interface."

Eitan Rindenau
Performance Engineer
Gas Turbines, IEC

Solution components

- IBM SPSS Statistics

Industry

- Utilities

Israel Electric

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Early Detection of Faulty Sensors

Quickly identify abnormal alerting behavior of sensors along a cycle of turbine operation

Business challenge

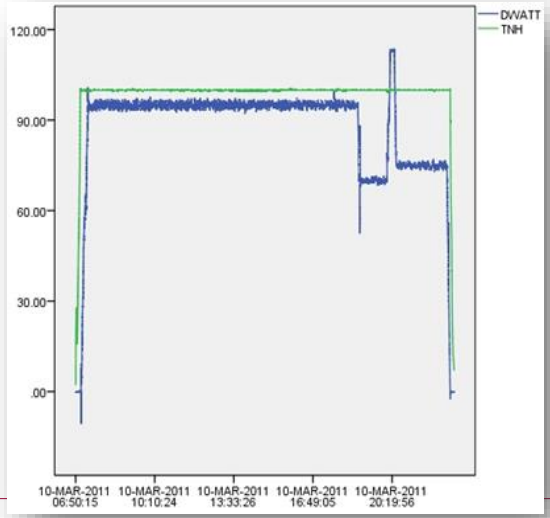
During a normal cycle of a turbine's operation, some sensors normally alert while others normally don't. An early detection of abnormal alerting behavior is important for timely maintenance, which in turn is crucial for proper functioning and monitoring of the turbine.

Solution

A designated script was designed on IBM-SPSS Statistics, which is hourly scheduled to run the following task:
Every hour, check if a cycle has ended. Within this cycle, identify faulty sensors of three types:
1. Unlike usually, alerted this time
2. Unlike usually, did not alert this time
3. Alerted too frequently (e.g. 10 times per hour)

Benefits

- The diagnostics of sensors is continuous, automated, focused and conclusive.
- Maintenance is performed right on time.
- Subsequently, sensors' data are more reliable.



"With the assistance of this automatic and "transparent" tool, I am being notified almost instantly about anomalous sensors operating across various units."

Alex Liberman
Performance Engineer,
Gas Turbines, IEC

Solution components

- IBM SPSS Statistics

Industry

- Utilities

Israel Electric

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Analysis of Turbine Startup and Shutdown Events

Comparative study of event duration and fuel consumption

Business challenge

Starting a turbine or shutting down another is a common daily task. However, when numerous turbines are involved, located in different sites and have a different schedule of maintenance, it gets harder to inspect these basic operations at the beginning and ending of each work cycle.

Solution

Once a day, automatically, IBM-SPSS Statistics identifies all startup and shutdown events across all units in the last 30 days, and analyses them:

1. Unit-level reports, elaborating each event (duration and fuel consumption).
2. Overall report, comparing the turbines to one another.
3. SPC analysis, identifying outliers and trends of interest.

Benefits

- Automated analysis of events across all units.
- ROI: Shortly after implementation, an outlying turbine was identified and re-calibrated, thus saving $75,000 per year on fuel consumption.

profile | events | liquid | Gas | duration

event_type	fuel_type	site	unit	count	liquid_median	liquid_min	liquid_max	gas_median	gas_min	gas_max	duration_minutes_median	duration_minutes_min	duration_minutes_max
shutdown	gas	HG	4	6	0.77	0.00	1,523.28				3.28	0.03	7.85
shutdown	gas	RH	1	2	0.00	0.00	0.00	62.44	51.36	73.51	2.48	2.20	2.75
shutdown	gas	RH	2	1	0.00	0.00	0.00	23.43	23.43	23.43	3.55	3.55	3.55
shutdown	gas	RH	3	1	0.00	0.00	0.00	435.96	435.96	435.96	7.93	7.93	7.93
shutdown	gas	RH	4	75	0.00	0.00	51.97	207.00	147.86	297.38	3.30	2.25	4.07
shutdown	liquid	HG	4	21	1,834.88	56.93	2,767.95				3.37	0.18	10.70
shutdown	liquid	RH	1	53	1,429.39	1,164.42	1,936.99	1.15	0.08	14.09	2.82	2.50	2.98
shutdown	liquid	RH	2	91	1,583.66	1,256.45	2,114.53	0.00	0.00	2.95	3.75	3.07	4.53
shutdown	liquid	RH	3	25	2,808.94	2,038.70	4,131.77	0.00	0.00	0.02	6.00	4.63	7.53
shutdown	liquid	RH	4	4	1,475.11	1,352.62	1,593.42	0.00	0.00	7.88	3.56	2.95	3.90
startup	gas	HG	4	13	0.00	0.00	0.00				6.15	5.78	6.42
startup	gas	RH	1	50	0.00	0.00	82.93	232.21	186.15	244.76	8.08	7.82	8.67
startup	gas	RH	2	82	0.00	0.00	70.21	57.83	44.27	76.78	7.80	7.60	8.33
startup	gas	RH	4	78	0.00	0.00	142.75	486.28	441.93	593.07	7.96	7.75	9.33
startup	liquid	HG	4	21	4,984.95	4,035.91	5,987.79				6.77	6.52	8.10
startup	liquid	RH	1	7	4,048.59	3,896.54	4,828.72	2.21	1.82	28.03	8.58	8.32	8.80
startup	liquid	RH	2	12	4,397.69	2,641.16	4,799.66	0.00	0.00	6.17	8.48	8.25	9.17
startup	liquid	RH	3	27	3,947.26	3,811.55	4,842.07	0.00	0.00	0.08	8.40	8.18	8.85
startup	liquid	RH	4	6	3,982.28	3,825.06	4,254.46	0.00	0.00	19.47	8.45	7.92	10.62

Max, min & median

"Starting up a turbine and shutting it down are critical operations. Having this new technology enables us to keep track, analyze them and identify specific anomalies as well as trends of degrading performance."

Eitan Rindenau
Performance Engineer
Gas Turbines, IEC

Solution components

- IBM SPSS Statistics

Industry

- Utilities

Israel Electric

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Temperature Control in Exhaust System

Immediate identification of precursors to severe damages

Business challenge

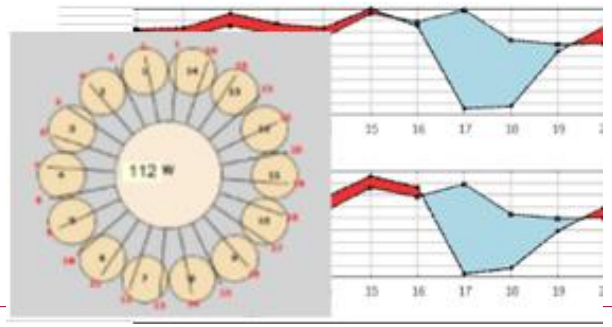
Following a harsh incident in which several components of a turbine's exhaust system suffered damages, a thorough investigation revealed abnormal temperature differences between pairs of neighboring thermocouples, named "sinkings".

Solution

In order to prevent such damages in the future, a system was developed using IBM-SPSS Statistics. It automatically examines all units every 10 minutes, and alerts immediately in case a sinking is found.

Benefits

- The system notifies the control engineer on a near-realtime basis of temperature abnormalities, thus it enables him to avoid such damages, expensive maintenance and turbine downtime.



"This system was developed for us by Genius Systems with IBM SPSS's technology, due to significant and expensive damages incurred to our turbines. Now we are able to automatically predict failures and therefore avoid costly damages."

Alex Liberman
Performance Engineer,
Gas Turbines, IEC

Solution components

- IBM SPSS Statistics

Industry

- Utilities

Israel Electric

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Analysis of Fuel Consumption

Identification of units which consume more than expected

Business challenge

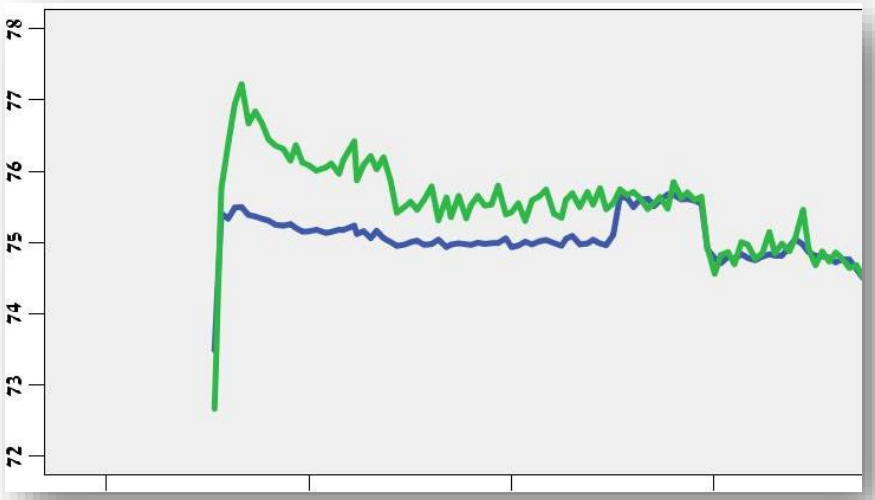
Purchasing of fuels is one of the major expenditures in the process of electricity manufacturing. This is even more true when only liquid fuel is available, as opposed to gas. Under such circumstances, saving fuel means saving substantial amounts of money.

Solution

A wasteful turbine is defined as one which consumes more fuel than it should under similar conditions. Hence, given a large amount of data, a Neural-Network (NN) predictive model has been trained for each unit in each site, to define the expected fuel consumption at any time. Every morning, data is collected for the recent 24 hours, for calculating the expected consumption using this NN model and comparing it with the actual amount. A large difference indicates waste, and alerts for further inspection.

Benefits

- Daily identification of wasteful units focuses the measures taken to reduce fuel consumption and related expenditures.



"Extraneous fuel consumption is nothing but a waste of money. This system, developed for us by Genius Systems with IBM SPSS's technology, is a critical step towards identifying and reducing significant fuel expenses in every single unit, as much as 75K$ per turbine per year."

Eitan Rindenau
Performance Engineer,
Gas Turbines, IEC

Solution components

- IBM SPSS Modeler

Industry

- Utilities

Israel Electric

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Monitoring of Key Temperatures & Pressures

Daily analysis of Key Performance Indicators

Business challenge

From among hundreds of tags that are routinely recorded for each unit, there are approximately a dozen of Key Performance Indicators (KPIs) which serve as a basis to evaluate its condition. These include several oil temperatures, pressure ratios ,gas emission, etc. A comprehensive overview of units' status requires ongoing monitoring of all the KPIs across all units. Moreover, each of these measures tends to behave differently under different workloads and / or environmental conditions.

Solution

A large data set was gathered for each unit, reflecting the behavior of each KPI under a multitude of conditions. Consequently, a Neural-Network (NN) predictive model has been trained for each KPI in each unit in each site. Every morning, data is collected for the recent 24 hours, for calculating the expected value of each KPI using the NN models and comparing them with the actual values. The control engineer is consequently alerted for any large difference that is found.

Benefits

- The control engineer is given a tool for daily diagnostic of all units, with highlighted irregularities.
- The system is supplemented with a stream that enables the engineer to interactively select KPIs and time limits for custom analyses.

"Constantly monitoring a multitude of parameters across many units is a very important to keep turbines working smoothly. This system facilitates the engineer's work and enables him to produce both predefined and custom-made analyses."

Eitan Rindenau
Performance Engineer,
Gas Turbines, IEC

Solution components

- IBM SPSS Modeler

Industry

- Utilities

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