



**We Know When
Machines Fail**

Captain Kirk and Mr. Spock of predictive maintenance: Combining expert knowledge with advanced data analytics

HMI 2017, MDA Forum

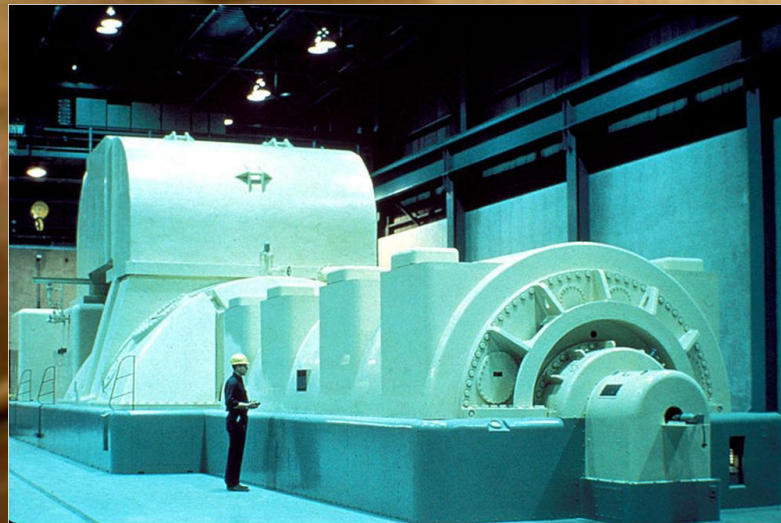
CASSANTEC

Cassandra

Prophet of critical future events in Greek mythology

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*I wish I knew when
my turbine will fail?*





*Lucky me,
I have Mr.
Spock by
my side*



**Optimized
maintenance &
repair**



**Improved
production
planning**



**Retention of
critical
knowledge**

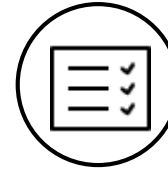
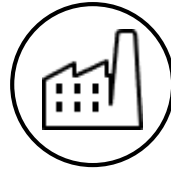
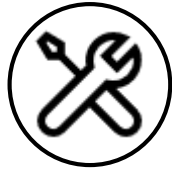


**Enhanced
reporting
transparency**



**Financial
benefit
levers**

CASSANTEC



- English
- Deutsch
- Français
- 中文
- Русский

Demo version

Report no.: DEMO.DEMO.HPP.TUR3.SUMMARY.20160314-00

Date: 04 Oct'18

Version: 1.20, Release: 0.2

Observations

Clear all

Prognostic report

Provided by CASSANTEC

DEMO

WF

CMP

SSP

HPP

TUR1

Data TUR1_

Data TUR1_

Data TUR1_

Data TUR1_

Data TUR1_

Data TUR1_

Latest par

TUR2

Data TUR2_

Data TUR2_

Data TUR2_

Data TUR2_

TUR3

Data TUR3_

Data TUR3_

Data TUR3_

Latest par

GNR1

GNR2

GNR3

TSF1

TSF2

Equipment specification

Operator name	Demo
Unit name	HPP
Unit location	Switzerland
Contact person	Don Demo
Phone	123-456-0987
E-mail	don.demo@examplecorp.com
Component type	Bulb turbine
Component OEM & model	OEM demo, model demo
Component group	TUR3
Serial number	TUR3
Elements monitored	Shaft, bearings, impeller disk
Alarm owner	Don Demo
Phone	123-456-0987
E-mail	don.demo@examplecorp.com

View ☒ Specification ☐ Location

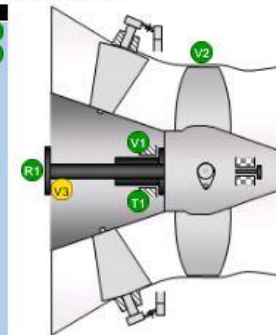
Condition diagnostics

Select

☒ V1 ☒ T1

☒ V2 ☒ R1

☒ V3



- Impeller
- Impeller feedback
- Shaft
- Coupling
- Radial bearing
- Hydraulic cylinder
- Vibration data
- Temperature data
- Rotation data
- Electrical data

Condition



Malfunction prognostics

Select	Malfunction modes	Data sources	Oct'16	Jan'17	Apr'17	Jul'17	Oct'17	Jan'18	Apr'18	Jul'18	Oct'18	Jan'19	Apr'19	Jul'19
<input checked="" type="checkbox"/> M1.1	Shaft crack	T1 V1 V2												
<input checked="" type="checkbox"/> M1.2	Coupling pin crack	T1 V1 V2												
<input checked="" type="checkbox"/> M1.3	Impeller blade crack	T1 V1 V2												
<input checked="" type="checkbox"/> M1.4	Impeller disk crack	T1 V1 V2												
<input type="checkbox"/> M1.5	Impeller disk wear													
<input checked="" type="checkbox"/> M1.6	Guide vane defect	V1 V2												
<input type="checkbox"/> M1.7	Oil inlet duct wear													
<input checked="" type="checkbox"/> M1.8	Radial bearing defect	T1 V1												
Total risk														

Next maintenance 04 Oct'16

Prognostic horizon (zoom) ☐ Short (12 days) ☐ Long (12 weeks) ☒ Maximum (12 quarters)

View ☐ Percentages

Vary load and data history

Load min. 0.01 l / min

History start 15 May'08

Load max. 100.92 l / min

History end 04 Oct'16

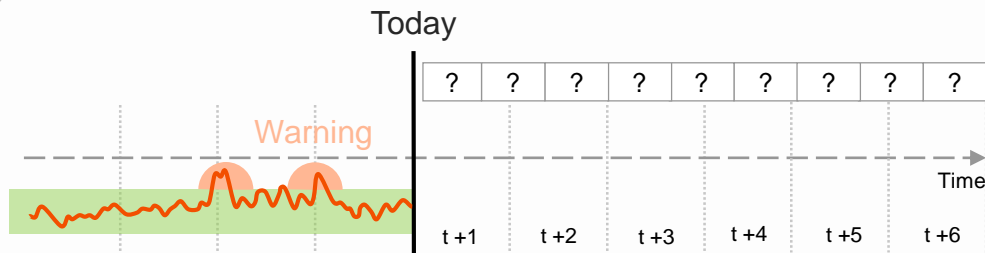
Schedule



Predictive Analytics generates early warnings

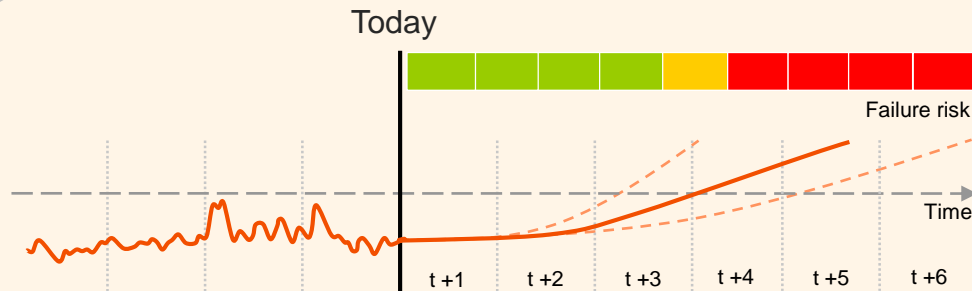
– Prognostics delivers true foresight

Predictive Analytics



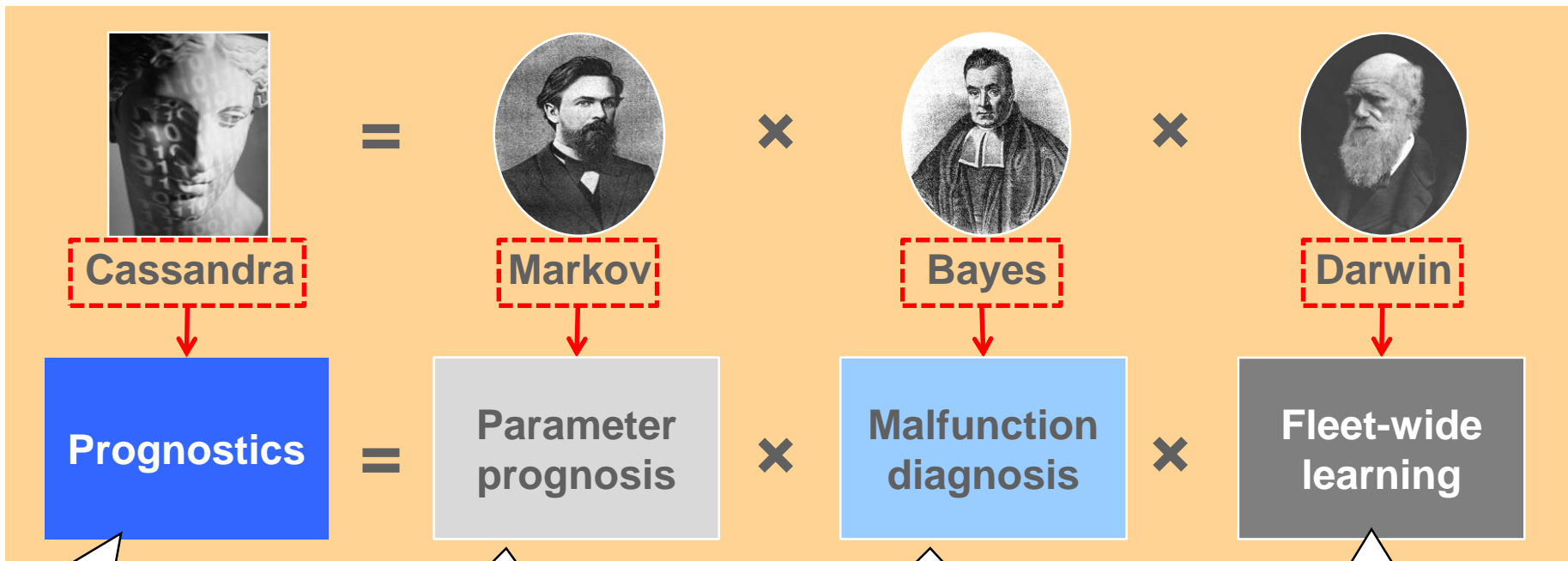
**Know that
something will
happen at some
point in the
future**

CASSANTEC Prognostics



**Know the
explicit time
window until
failure**

The technology is a unique and patent-pending combination of advanced mathematical methods



Calculation of Remaining Useful Life (RUL)

No physical modeling necessary

Stochastic prognosis (non-parametric model)

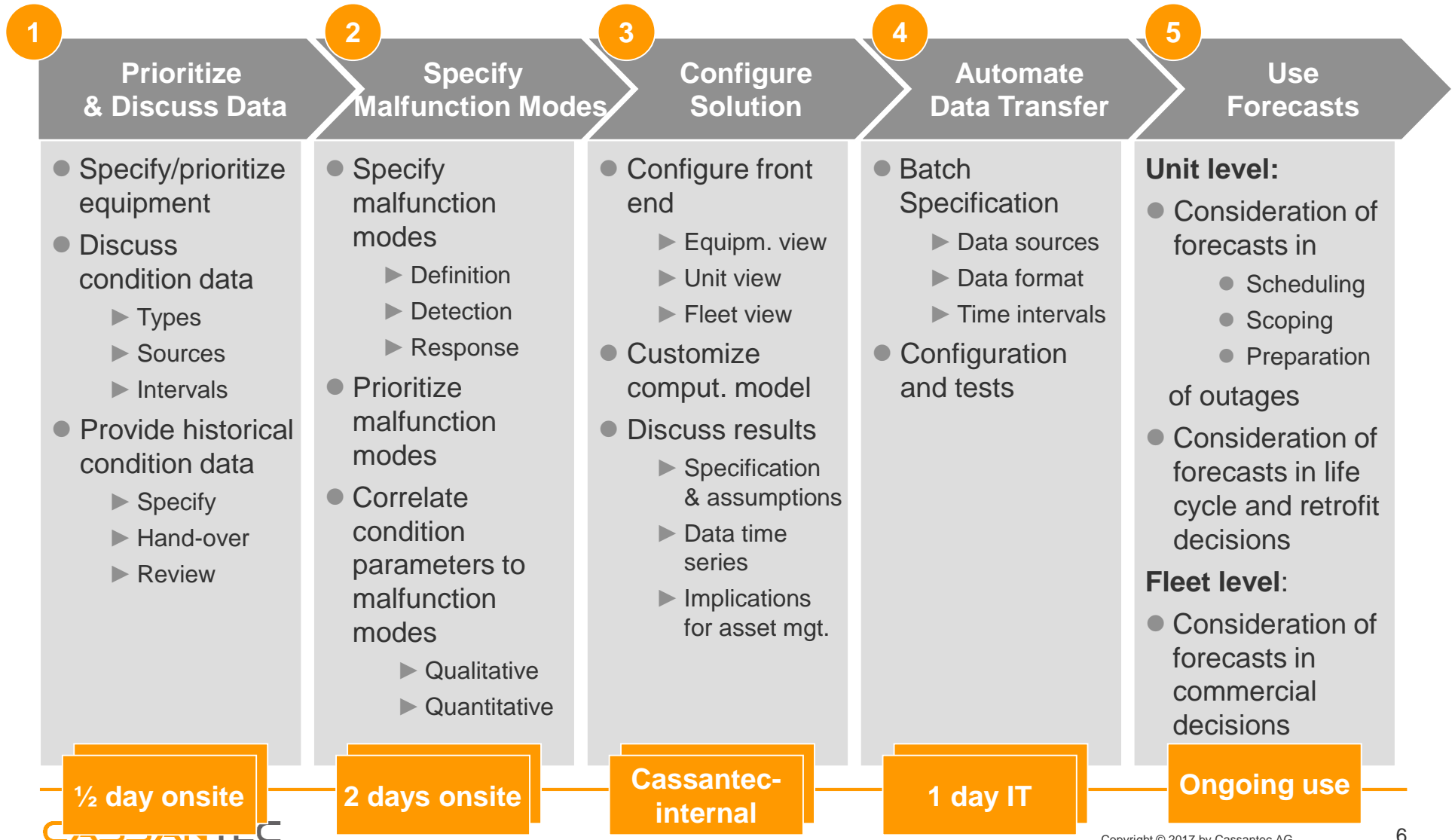
Automatic identification of operating scenarios, maintenance cycles and data outliers

Stochastic inference model

Not rule-based, therefore robust vis-à-vis unexpected changes

Machine learning on the basis of Markov and Bayes algorithms

The efficient configuration process comprises a “Kirk-step” and a “Spock-step”

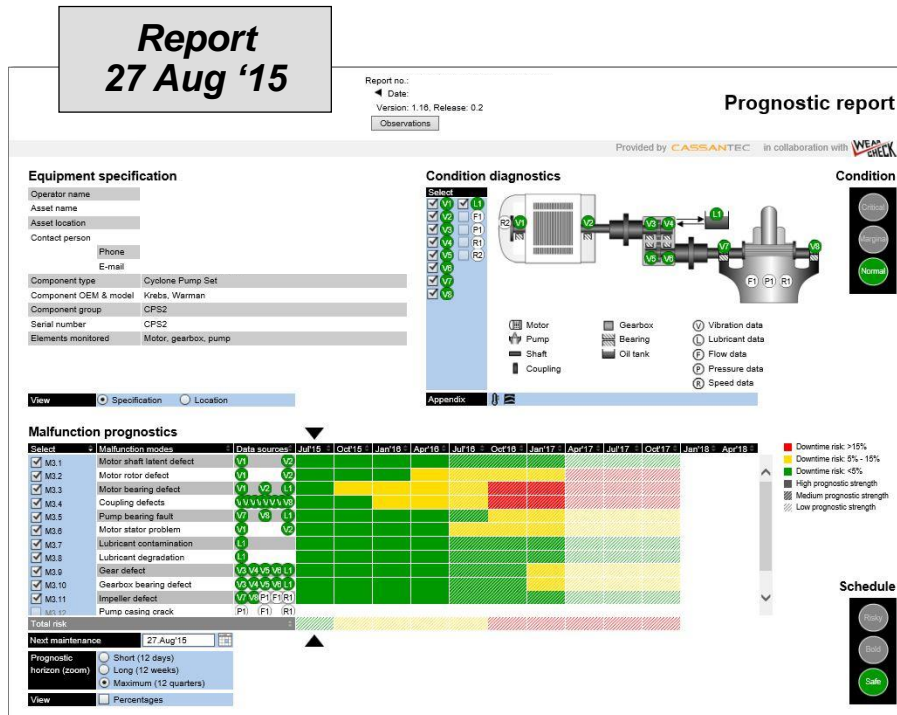


The benefits of knowing “when”

Improvement lever	Application examples
▶ Reduce unscheduled maintenance / repair	▶ “outage clusters”
▶ Shift maintenance into low-cost periods	▶ Avoid costly over-time
▶ Shift maintenance into low-revenue periods	▶ When electricity prices are low
▶ Reduced preventive scope and/or frequency	▶ Postpone routine work
▶ Manage Remaining Useful Life	▶ Adjustment of operational regime

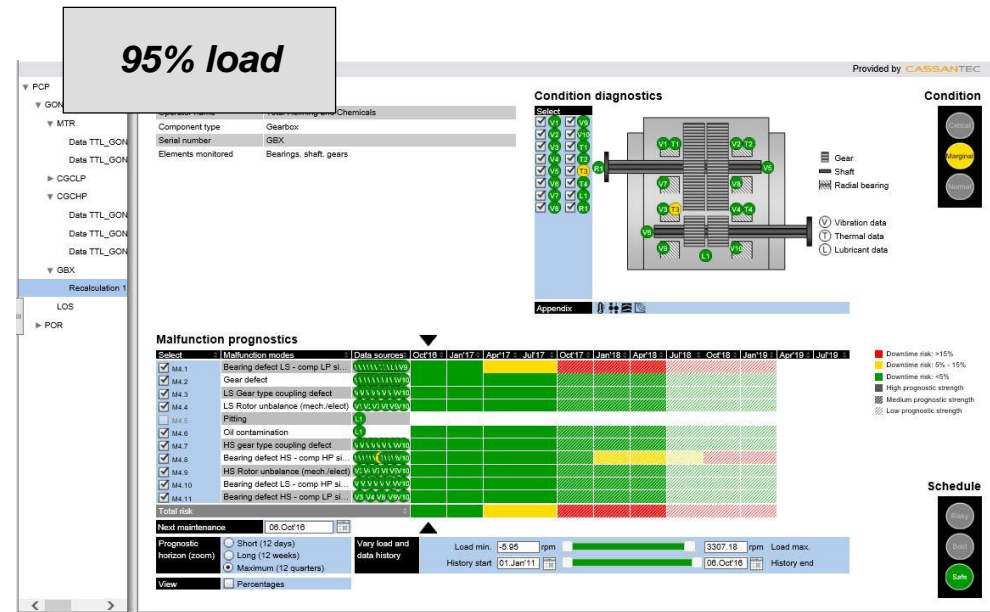
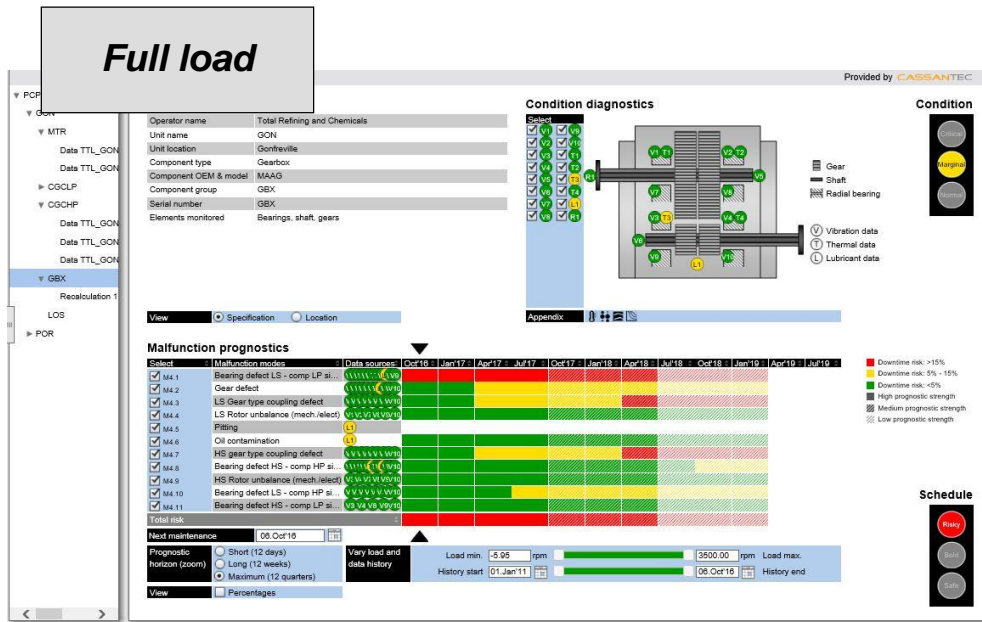
Short-term maintenance: an impending damage could be avoided without additional downtime

Prognostic Report for Cyclone Pump

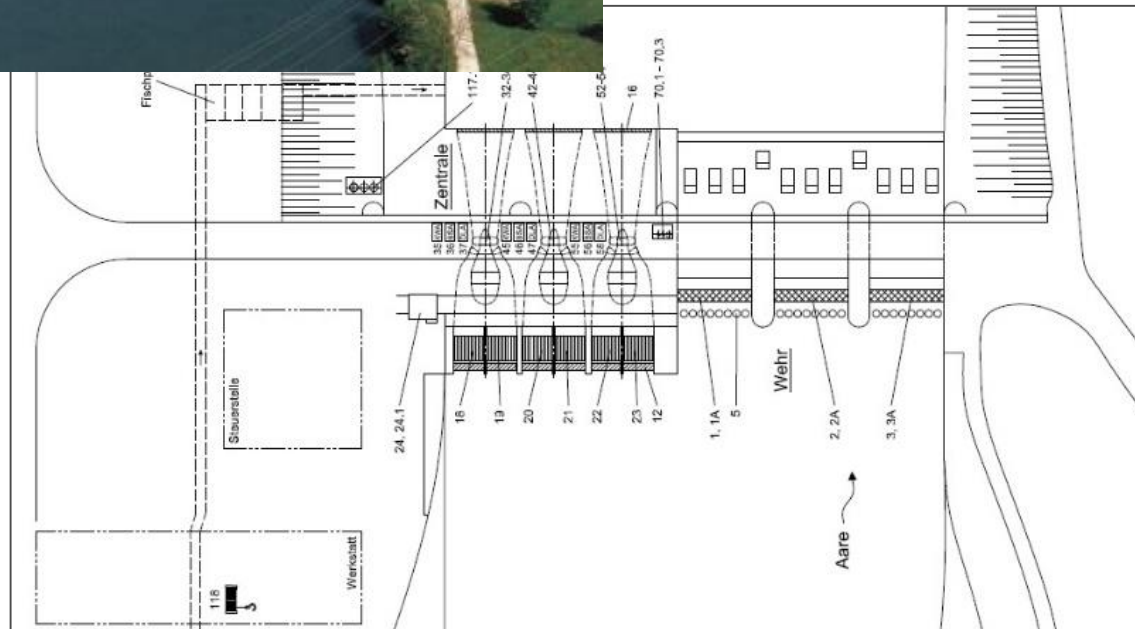


Production planning: load scenarios for an optimized link between maintenance and production

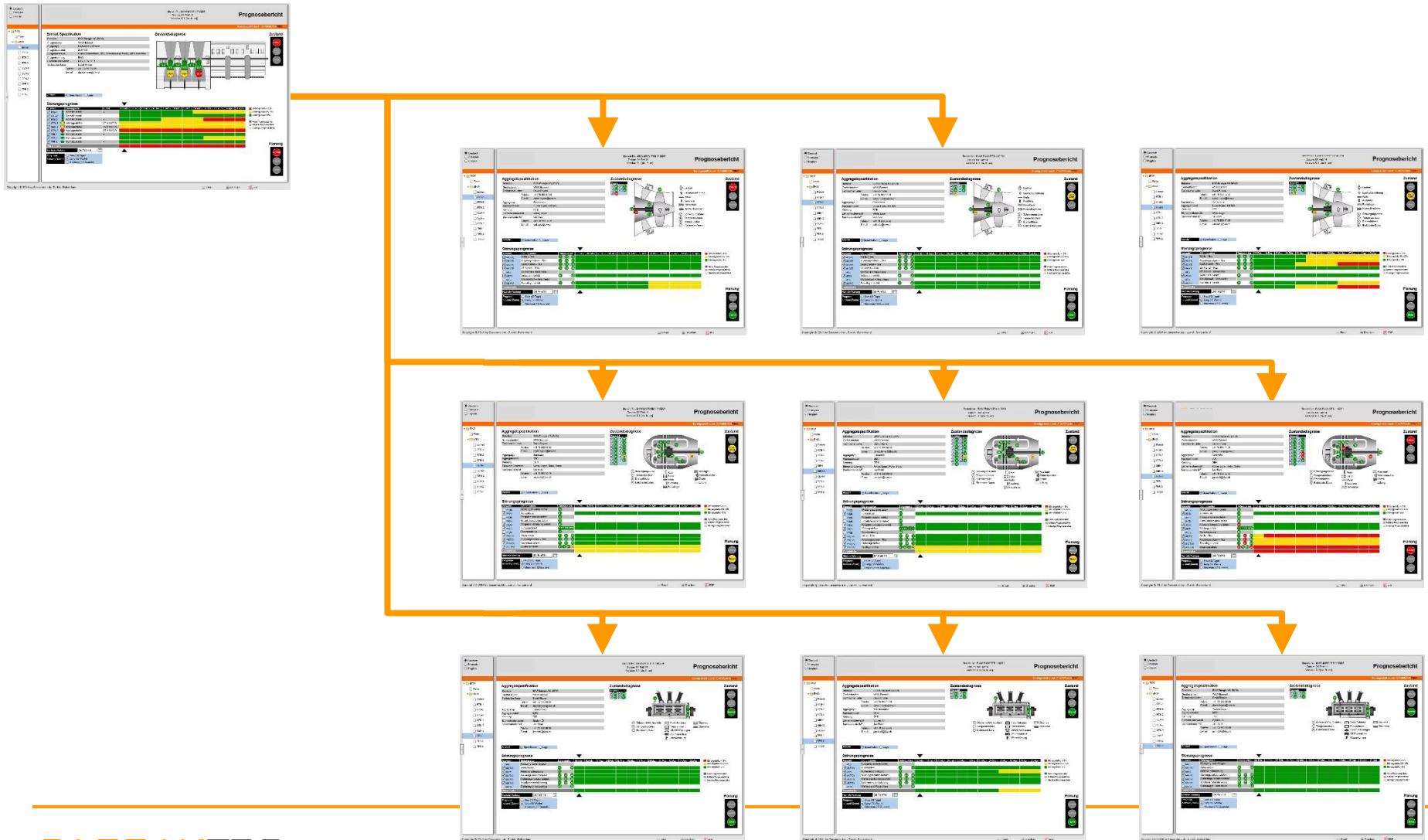
Prognostic Report for Gearbox of Compressor



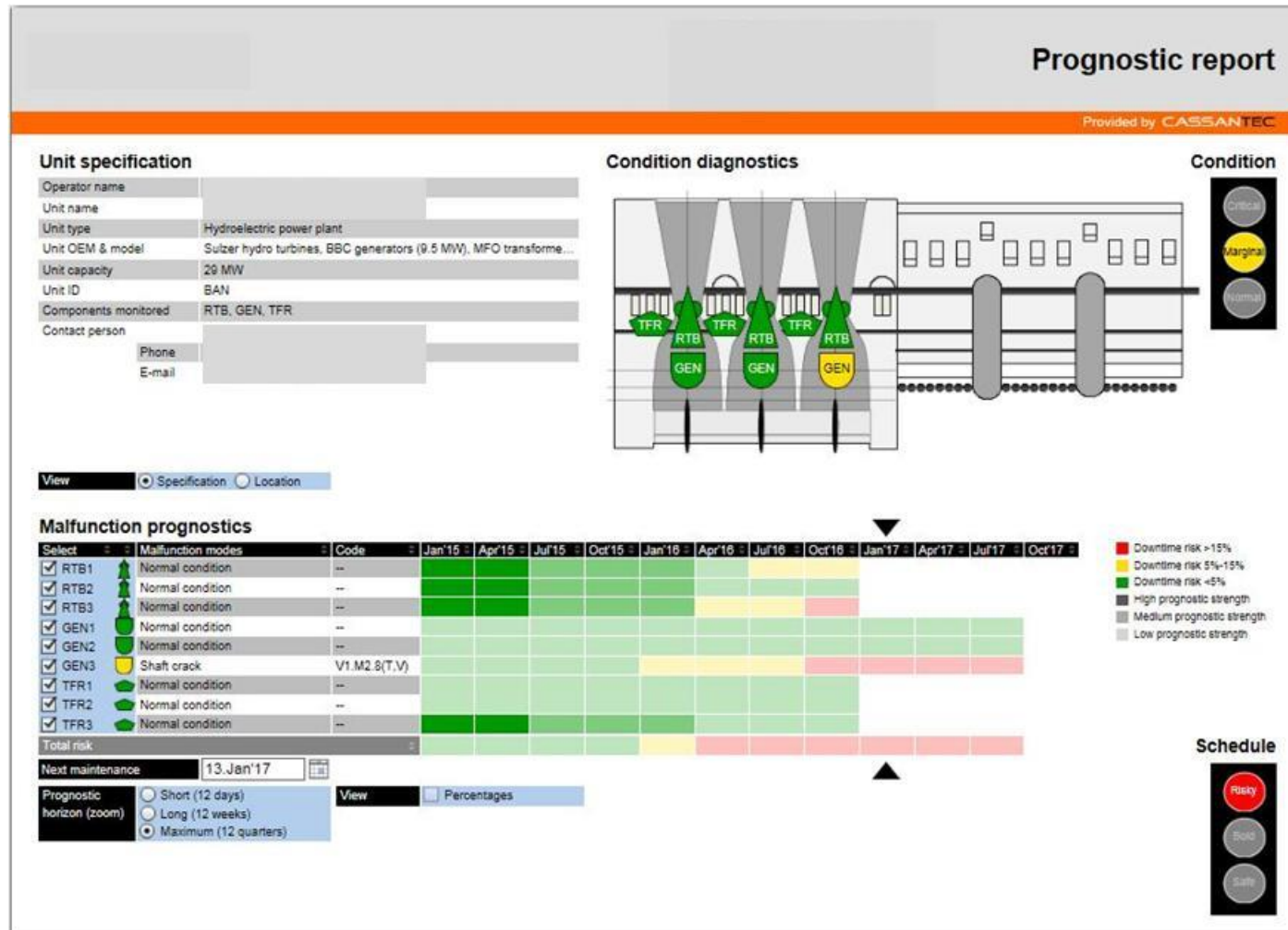
A run-of-river plant in Switzerland uses Prognostics



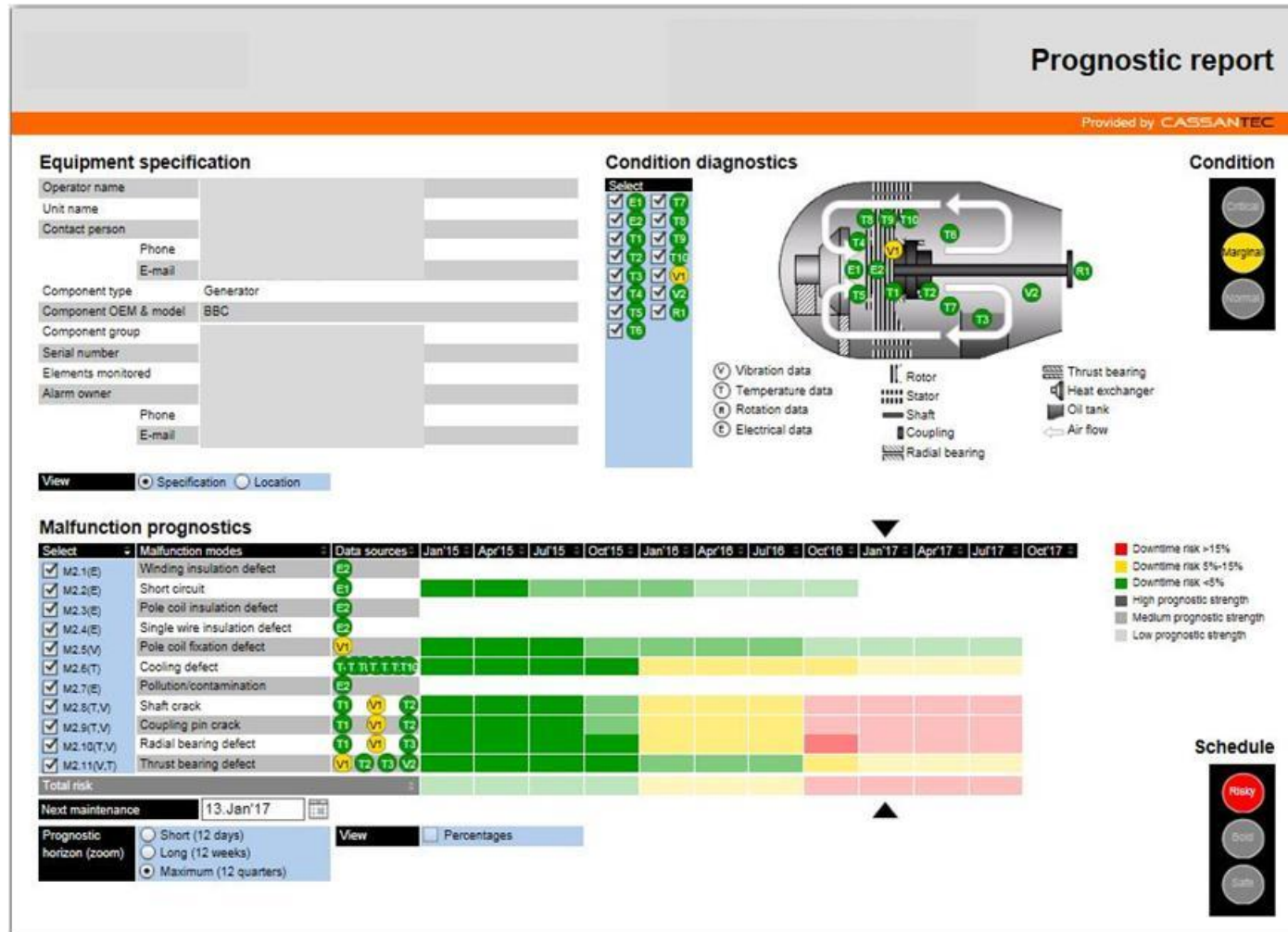
Three components are covered



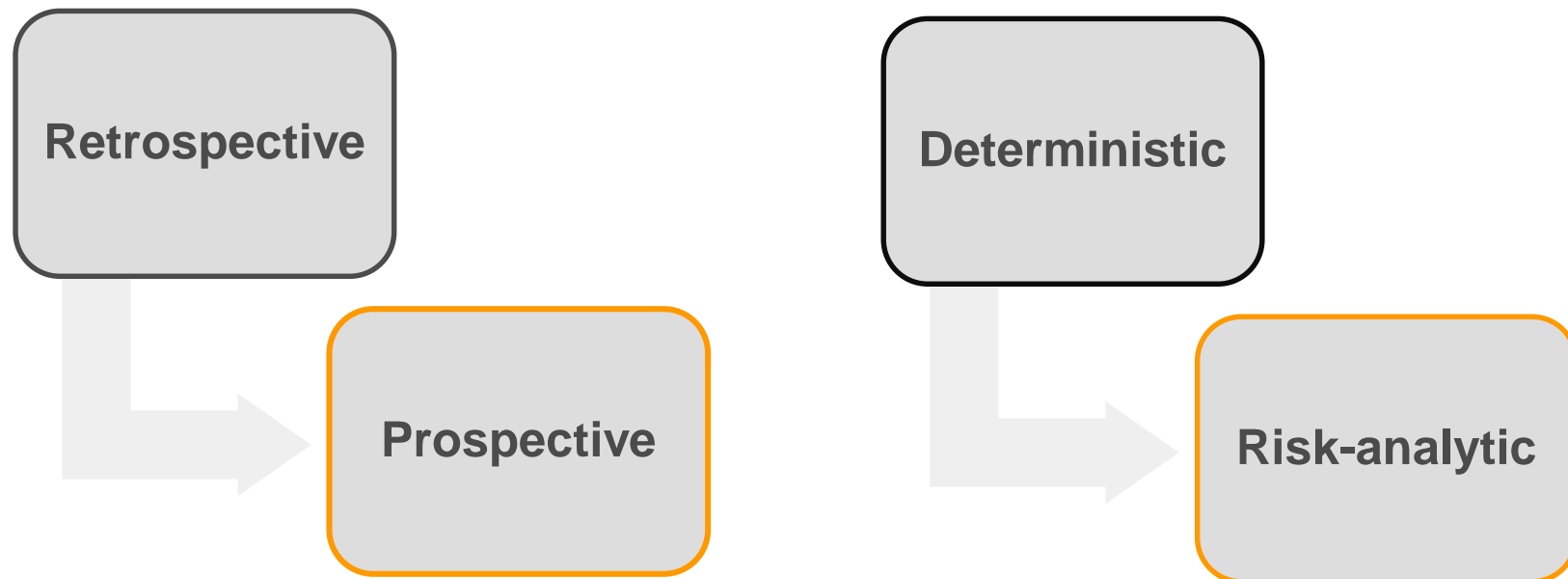
GEN3 limits the plant's Remaining Useful Life



Trouble stems from the shaft



Using Prognostics requires a double paradigm shift



The result is many use cases revolving around asset management (1 of 2)

Category	Use Cases
Maintenance and Repair	<ul style="list-style-type: none">▶ Long-term scheduling of maintenance▶ Short-term preparation of reactive maintenance▶ Maintenance staff planning and allocation
Operations	<ul style="list-style-type: none">▶ Production planning according to the future availability profile▶ Increased assets availability and minimized downtime risk for field projects, e.g. in upstream oil & gas
Finance	<ul style="list-style-type: none">▶ Saved profit opportunities from downtime reduction▶ Decreased annual maintenance costs▶ Increased total expected benefits petroleum assets operators▶ Optimized insurance policy and costs▶ Planning budget(s) and total cost of ownership (TCO)
Life Cycle Management	<ul style="list-style-type: none">▶ Replacement and retrofit planning▶ RUL-optimal exploitation▶ Active management of the remaining useful life by adjusting operating capacity

The result is many use cases revolving around asset management (2 of 2)

Category	Use Cases
Risk Management	<ul style="list-style-type: none">▶ Operationalization of risk valuation standards▶ Full transparency over future downtime risk for all critical assets components and active risk management
Procurement	<ul style="list-style-type: none">▶ Optimized parts and service procurement
General Management	<ul style="list-style-type: none">▶ Operationalized management reporting standards▶ Training of maintenance workforce and reliability through prognostic solution▶ Benchmarking: recognizable risk-impact of different operations strategies trough displayed risk profiles▶ Optimized health, safety & environment (HSE) reporting
Product Development	<ul style="list-style-type: none">▶ Original asset design and development of industrial assets▶ Timely retrofit and/or replacement of sensors

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