

Big Data & Digitalization: Big Confusion, Big Threat or Big Opportunity?

大数据与数字化: 混乱, 威胁, 机会?

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Scott Affelt

- 30 years in Energy business
- Co-Founder of XMPLR Energy
- Previously:
 - VP for Zolo Technology (combustion sensor)
 - President of Doosan/Babcock North America
- Experience:
 - Combustion, coal, natural gas, analytics, emissions control technology, optimization
 - USA, South Korea, China, Europe, India

XMPLR Energy/AVP Group 介绍

XMPLR Energy

- **Go-to-Market Consulting** 市场策略咨询
- **Technology Liaison** 技术分享
 - Licensing & Technology Transfer
技术许可与转移
 - Foreign Market Introduction
国际市场介绍
- **Data Analytics** 数据分析
 - Advanced Pattern Recognition
市场规律分析
 - On-line Performance Monitoring
在线评估
 - Advanced Controls Systems
控制系统
 - OEM Analytics Strategy
制造商数字化策略

AVP Group

- **Strategy Consulting** 策略咨询
- **Management Consulting** 管理咨询
- **Partnering/licensing** 合作/许可
- **M&A** 合并与收购
 - Sell/buy mandates 授权管理交易
- **Industry Focus** 专注行业
 - Power 能源
 - Waste-to-Energy 垃圾
 - Biomass 生物质
 - Renewables 可再生
 - Water 水处理
- **Regional Focus** 专注区域
 - North America 北美
 - Europe 欧洲
 - Asia 亚洲

What is Big Data什么是大数据?

What is Predictive Analytics什么是预测分析法?

What is Internet of Things 什么是物联网?

What is Industrial Internet of Things什么是工业物联网?

What is Internet 4.0 什么是互联网4.0?

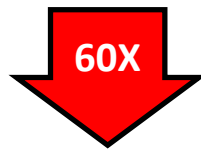
Why Big Data Now

为什么现在运用大数据的最好时机?

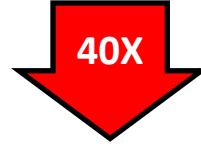
Cost of
Sensors
传感器成本



Cost of
Computing
信息处理成本



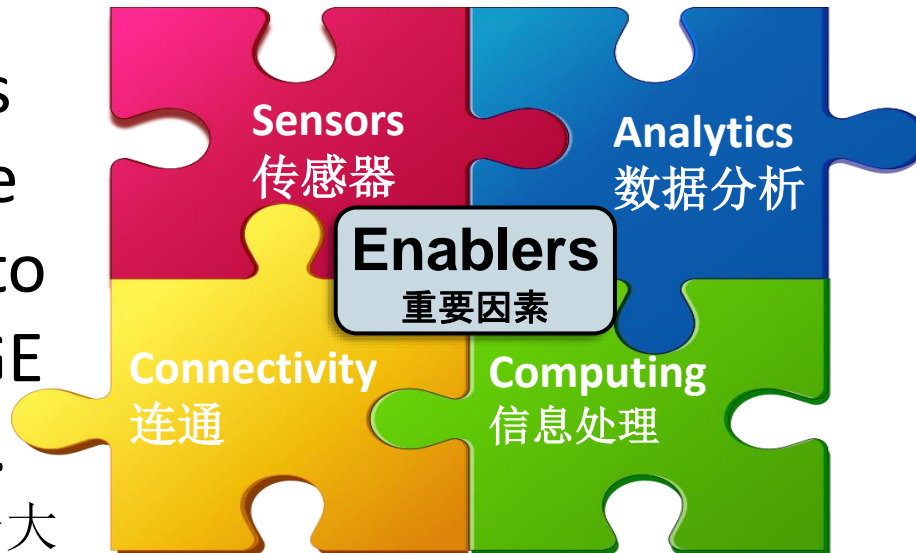
Cost of
Bandwidth
宽带化成本



Cost of
RAM/Storage
数据存储成本



Solutions
that were
provided to
only LARGE
assets
过去只适用于大
型工厂



... can now
be applied
to small and
mid-sized
assets
现在适用于所有
中小型企业

It's All Coming Together!
大数据已经万事俱备!

Source: Goldman Sachs Investment Research. Changes over last 10 years.

I'M A BOILER COMPANY, NOT GOOGLE.
我只是一家锅炉厂，而不是谷歌。

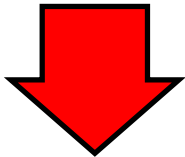
WHY DO I CARE ABOUT BIG DATA?
为什么我需要大数据？

Challenging Industrial Markets

充满挑战的工业市场

Capital Spending

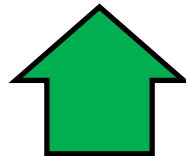
资产投入



NA Growth

北美市场增幅

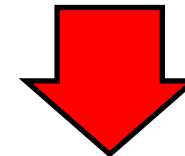
Competition 竞争



Europe Growth

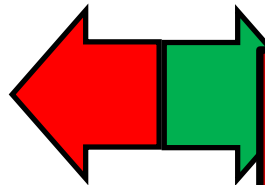
欧洲市场增幅

Profit Margin 利润



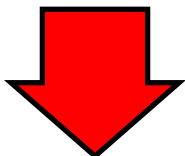
Asia Growth

亚洲市场增幅



Skilled Workforce

高技术劳动力



Want to Grow Your Business?

Status Quo Will Not Work!

Safe is Risky!

希望扩大企业收入与规模？

维持现状是危险的！

Consolidation

兼并

**What does Big Data
mean for You?**
大数据对你意味着什么？

Big Data is all about VALUE!

大数据就是价值的体现!

Value Created for Customer

为客户创造的价值

1. Produce More 产量增大

- More Capacity 更大容量
- Greater Throughput (rate/time) 更高速率
- Higher Reliability 更可靠

2. Lower Cost 成本减低

- Higher Efficiency 更高效率
- Greater Flexibility 更大弹性

3. Reduce Risk 风险减少

- Quality (rejects) 质量更高
- Lower emissions 排放更低
- Safety 更安全



Value
Alignment

Value Captured by You

你捕获的价值

1. Expand Markets 市场扩张

- New products/services 新产品/服务
- Expand wallet of existing base 从现有客户获得更多业务
- Capture competitor's base 抢占竞争对手领地
- Enter new markets 进入新市场

2. Higher Margins 更高利润

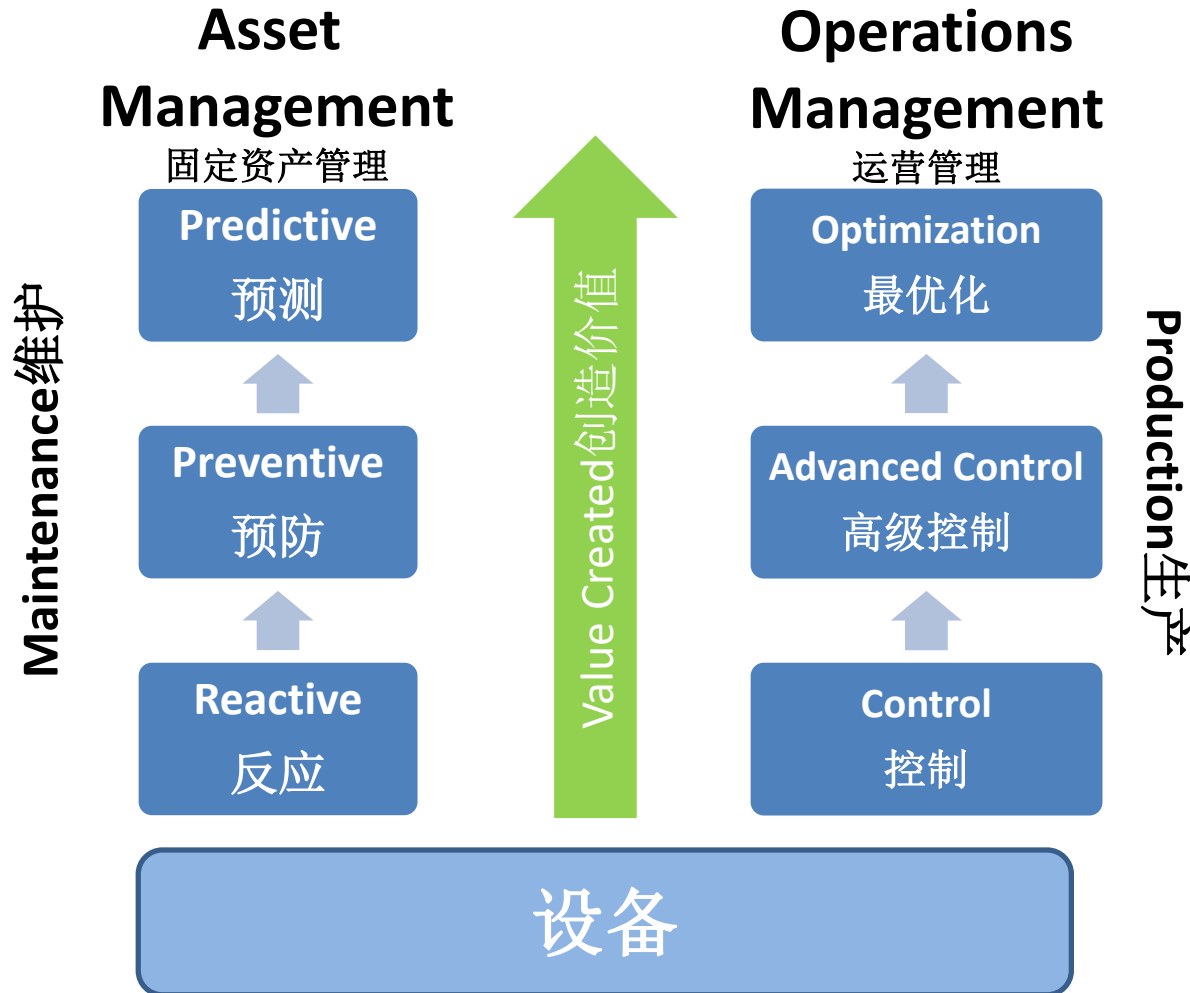
- Higher value products/services 产品/服务价值提升
- Reduce systematic costs 减少系统性错误成本
- Leverage legacy investments/capability 平衡过往投入/局限性

3. Monetize Unknown Value Buckets 从未知价值领域获取新收入

- Design optimization 设计优化
- Domain expertise/knowledge 技术资源整合
- New Services/offerings 新服务
- Value of the data 数据价值

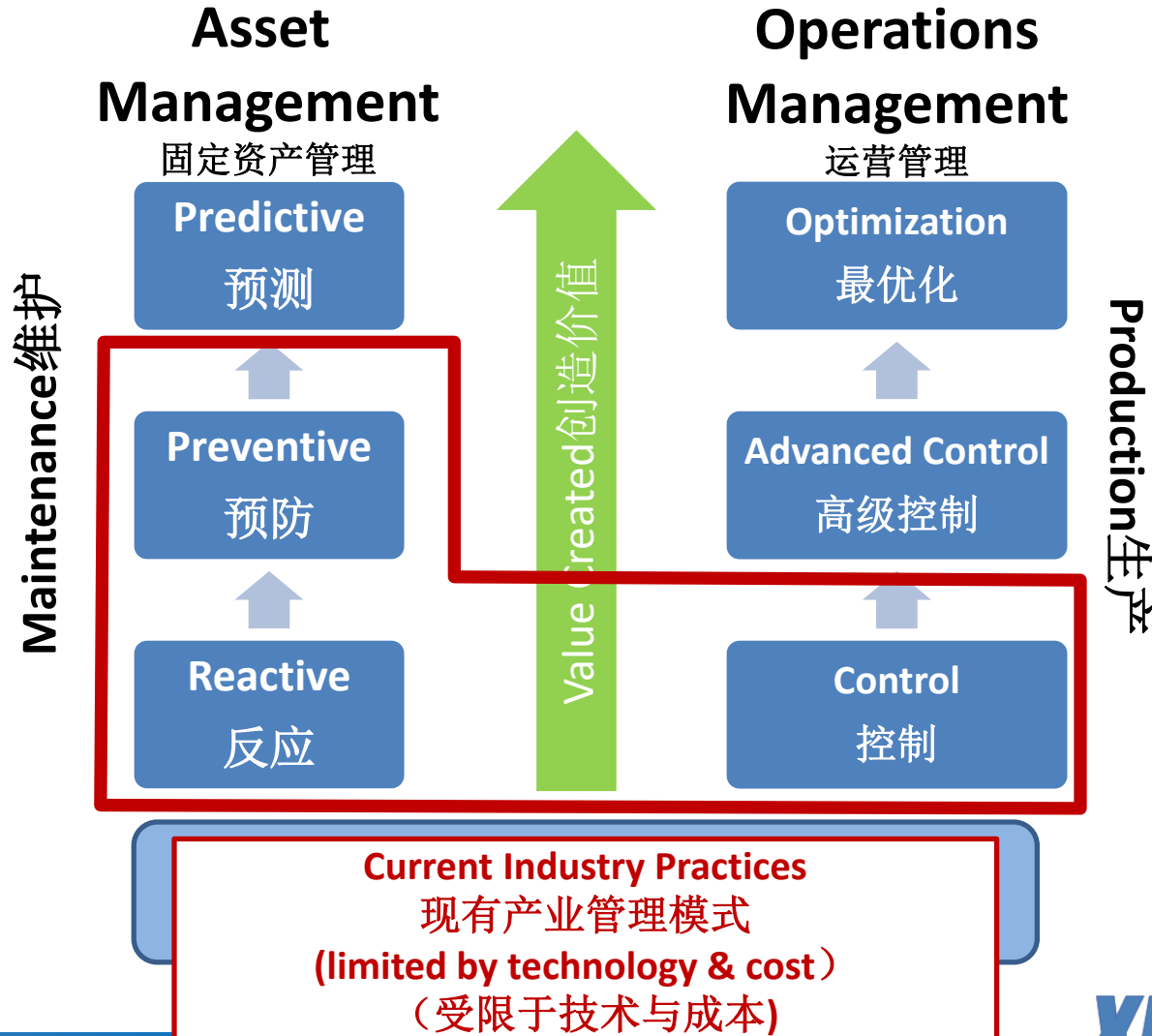
Asset Performance Management

设备运行管理



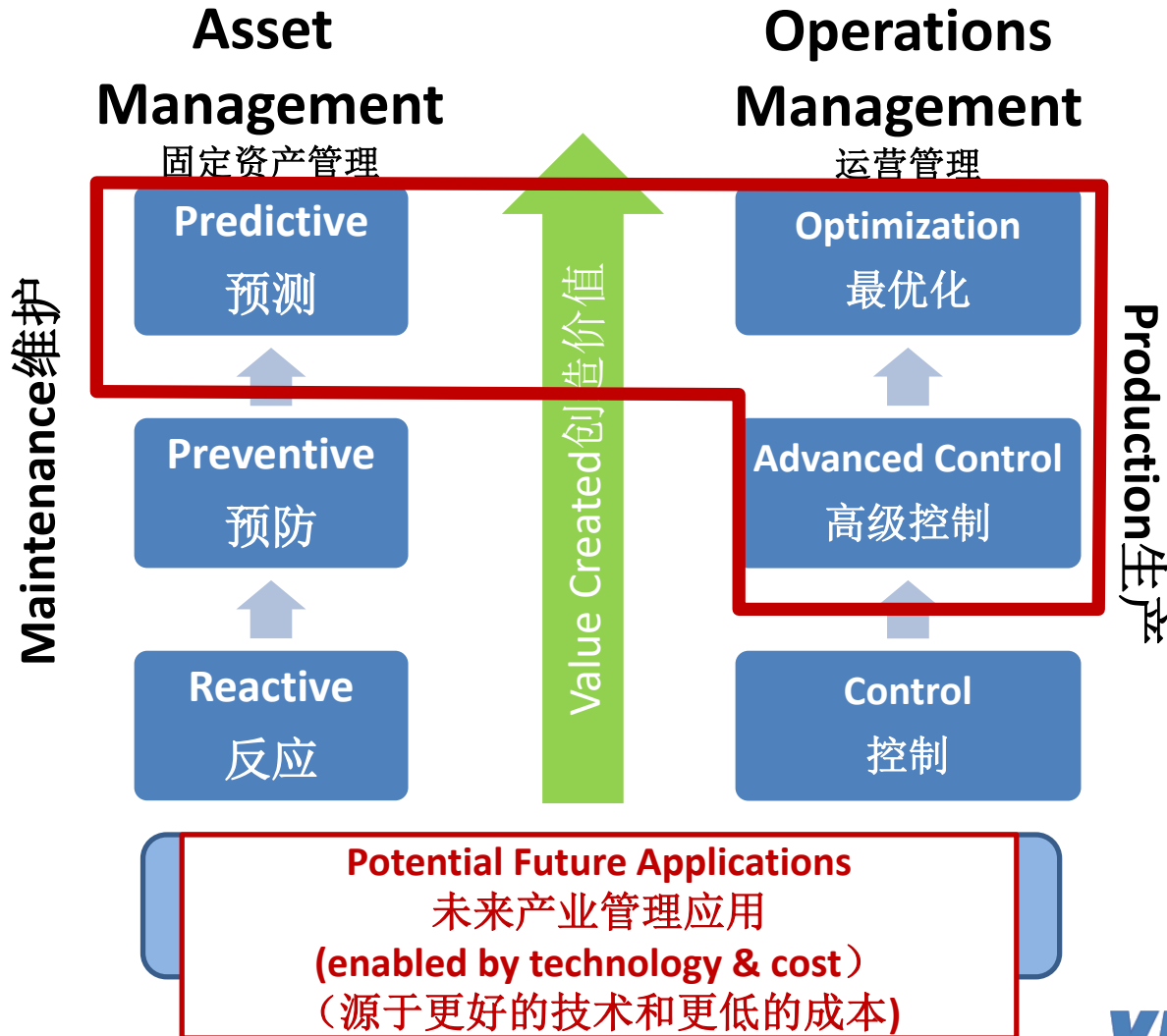
Asset Performance Management

设备管理



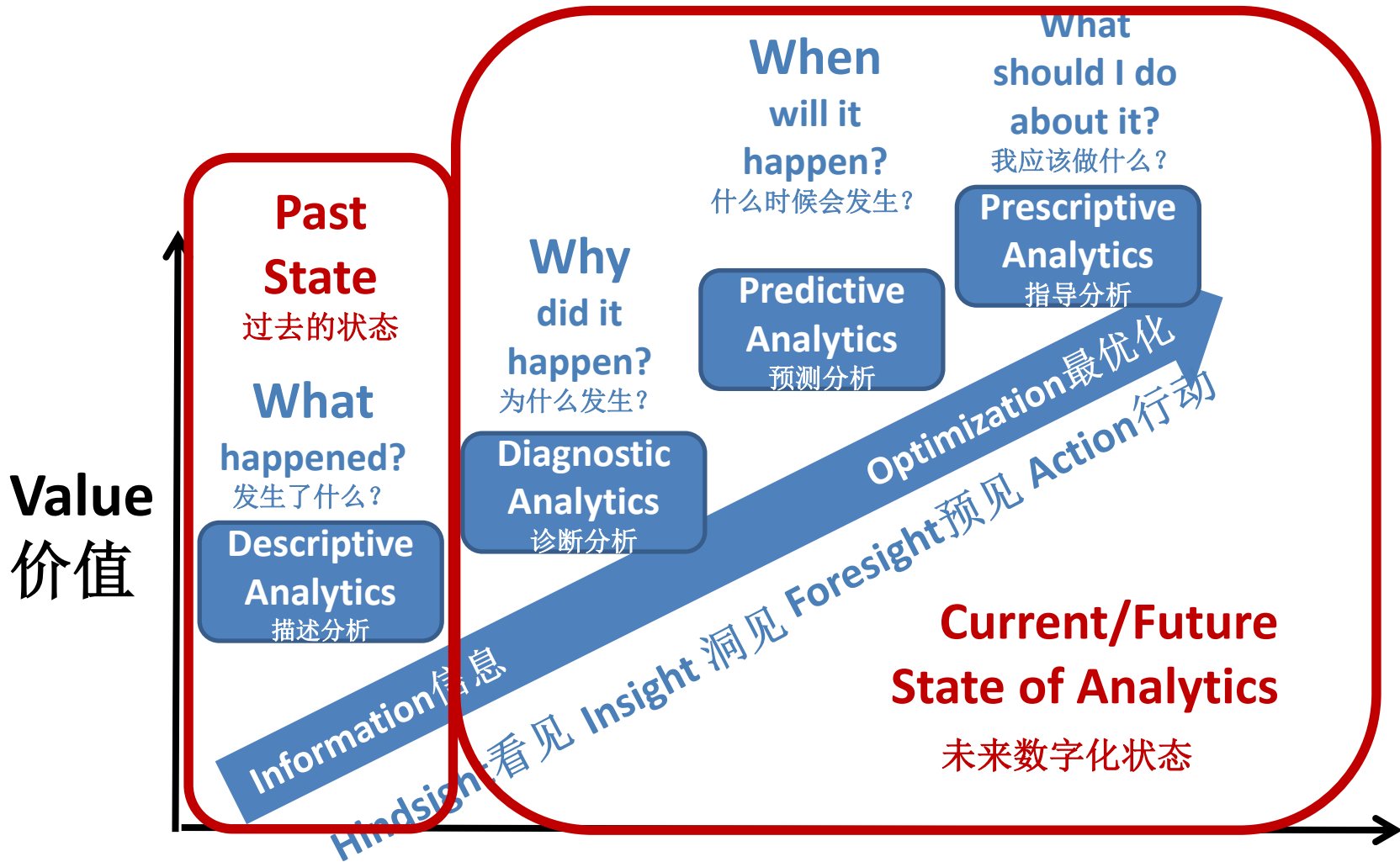
Asset Performance Management

设备管理



How Big Data Adds Value

大数据如何增加价值？



Source: Gartner

Difficulty 难度

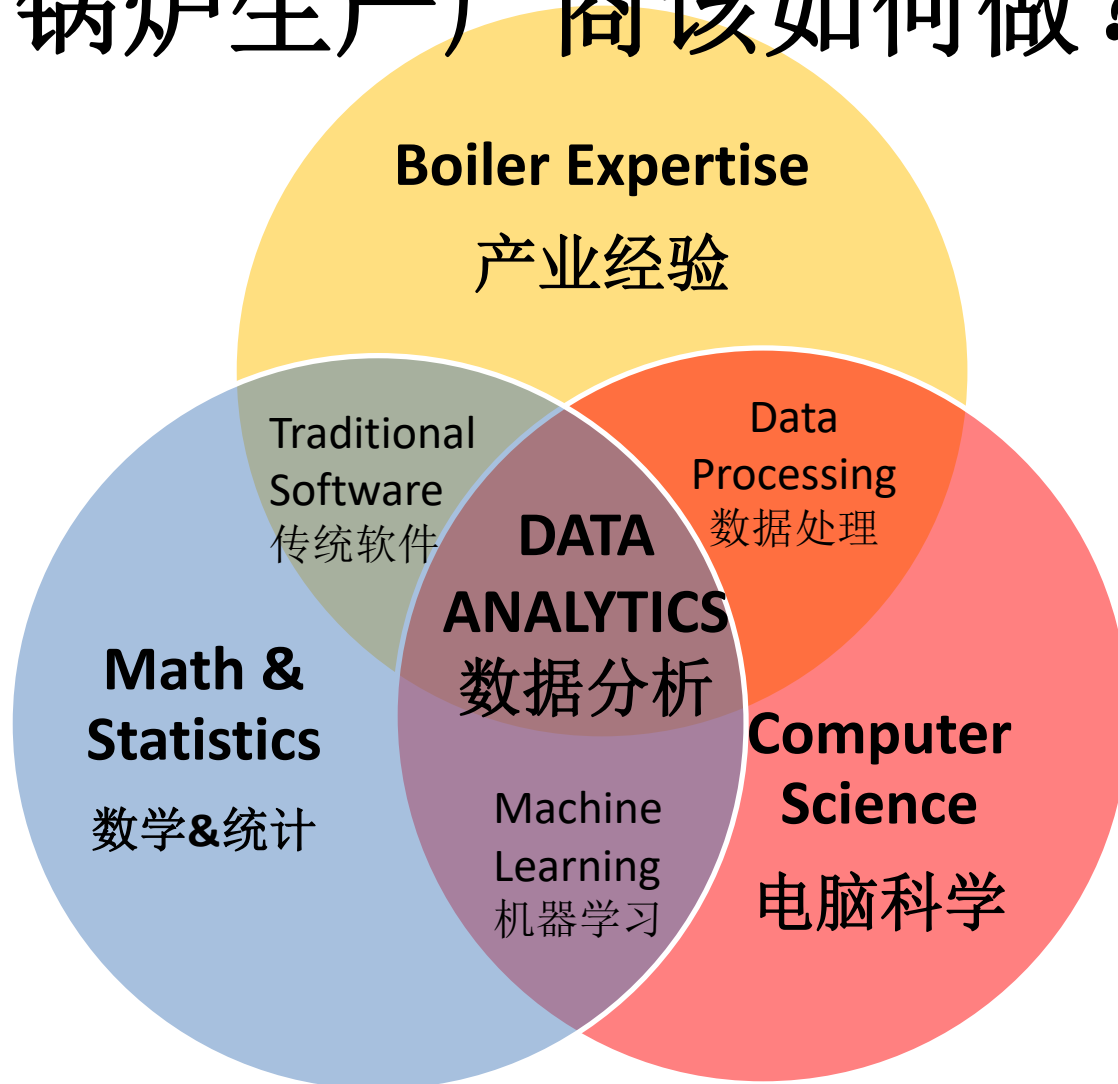


Key Areas of Value Creation

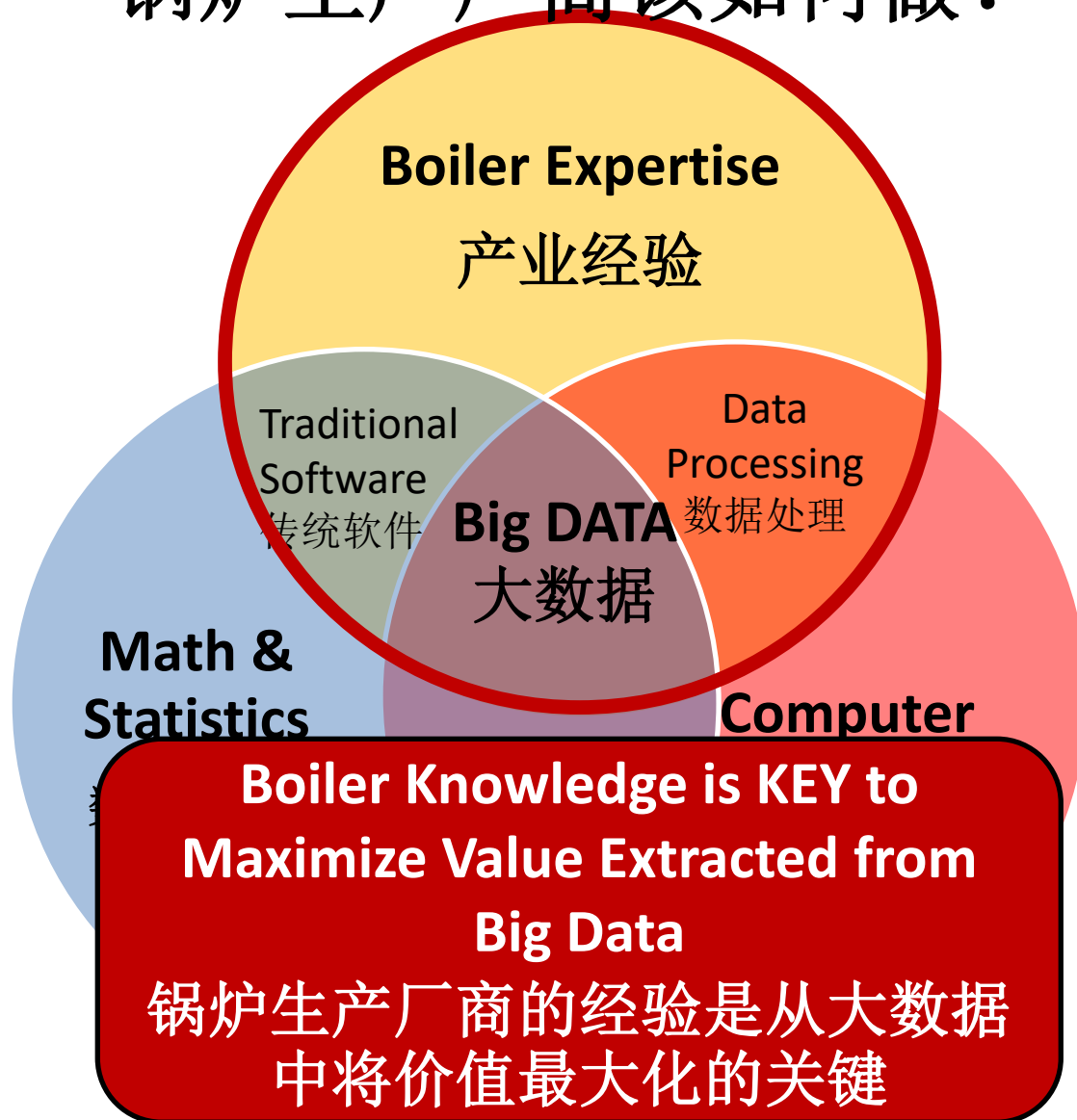
价值创造的重点区域

	Benefits 优点	Value Created 价值创造
Predictive Maintenance 预测性维护	<ul style="list-style-type: none">• Early detection of failures 预知系统故障• Improved maintenance planning Remaining useful life 优化维护计划• Lengthen maintenance intervals 延长维护间隔	<ul style="list-style-type: none">• Reduce downtime by 35% 停产时间缩短35%• Reduce unplanned outages by 70% 减低突发运行中断次数75%• Reduce maintenance costs by 25%. 降低维护成本25%• Increase availability 提高设备有效使用时间
Performance Monitoring 表现监测	<ul style="list-style-type: none">• Identify specific components contributing to inefficiency 识别低效部分• Improved thermal efficiency 提高热效率	<ul style="list-style-type: none">• Improve efficiency by 2-8% 提高效率2-8%• Maintain optimum capacity 维持最佳产量
Advanced Controls 高级控制	<ul style="list-style-type: none">• Optimized process control 优化流程控制• “Best” operator 24/7 24小时放心运行• Optimize over transients 应对瞬时变化• Improve operational flexibility 提高运行弹性	<ul style="list-style-type: none">• Improve efficiency by 2-8% 提高效率2-8%• Maintain process quality 维持流程质量• Maintain process stability 维持流程稳定性

Where does the Boiler makers fit? 锅炉生产厂商该如何做？



Where does the Boiler makers fit? 锅炉生产厂商该如何做？



Changing Business Models

改变商业模式

Product-Driven Model

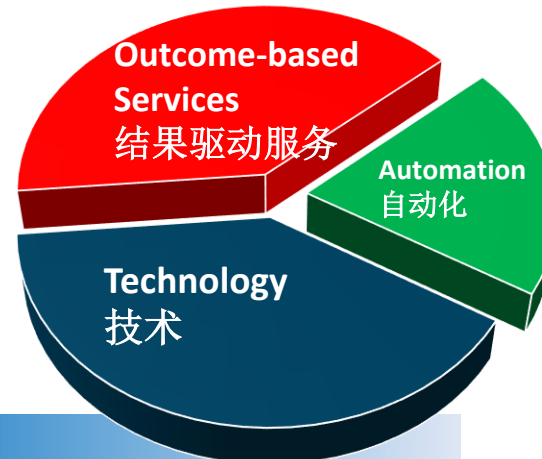
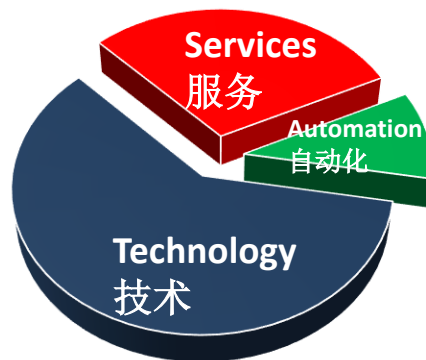
产品驱动模式

- Features/Benefits 特点优势
- Run-to-failure 故障测试
- Warranty response 保修维护
- Spares 备件
- Field Service 现场服务
- Retrofits/upgrades 升级改造

Outcome-Driven Model

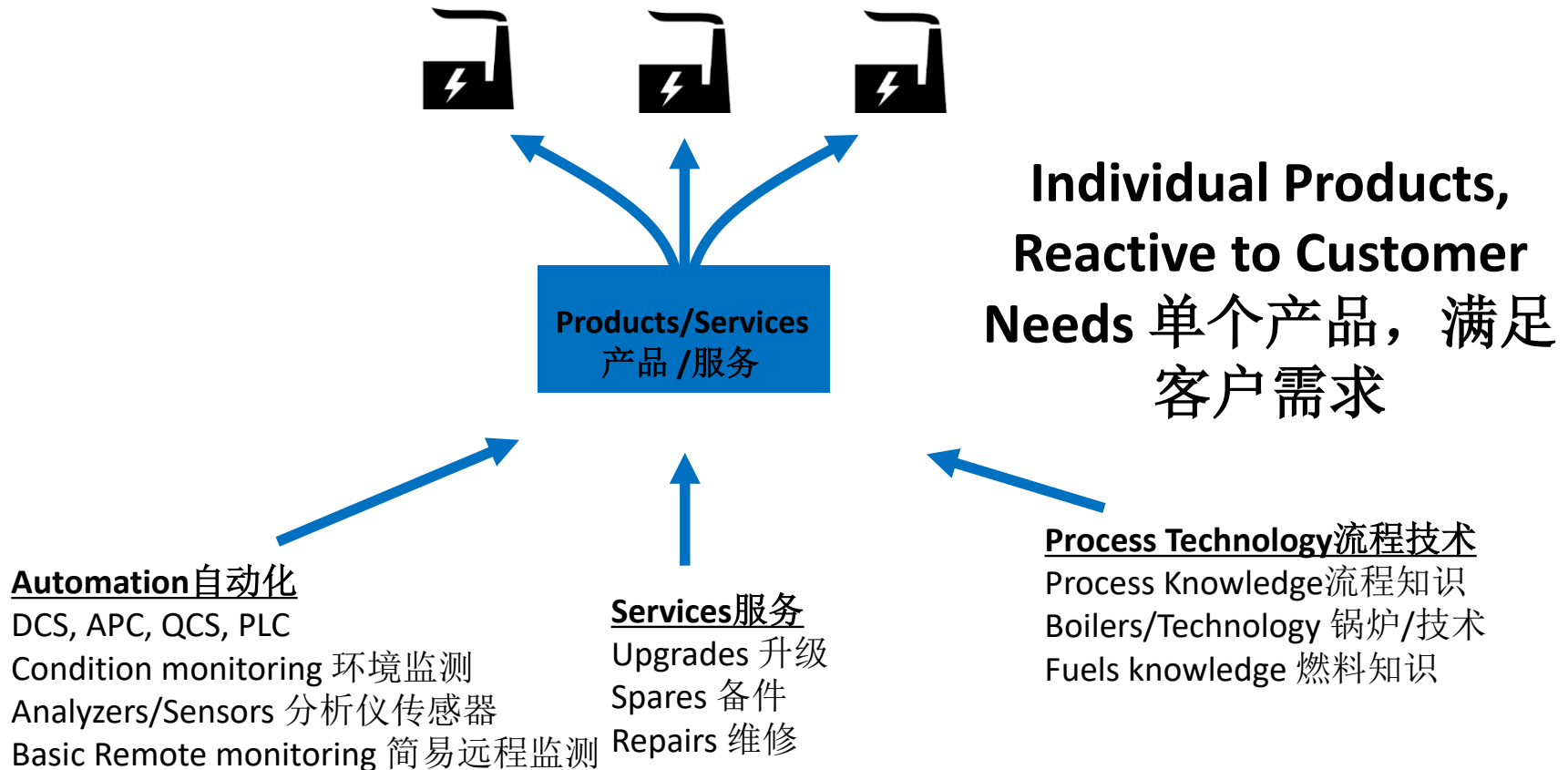
结果驱动模式

- Outcomes/Results 结果
- Superior Technology Solutions 高级技术方案
- Remote Monitoring 远程监测
- Predictive Maintenance 预测性维护
- Operating Performance 运行表现
- Design Optimization/Evergreen 设计优化
- Spares management 备件管理



Typical Boiler Company Eco-system

传统锅炉企业生态系统



Potential Future Eco-system

未来锅炉企业生态系统

New Value Buckets 新价值领域

Distributed Energy Resources

分布式能源

Demand Response Services

需求反应服务

Demand/Process Storage 流程存储

Micro-Grid Opportunities

微型电网

Automation 自动化

DCS, APC, QCS, PLC

Condition monitoring 环境监测

Analyzers/Sensors 分析仪传感器

Basic Remote monitoring 简易远程监测

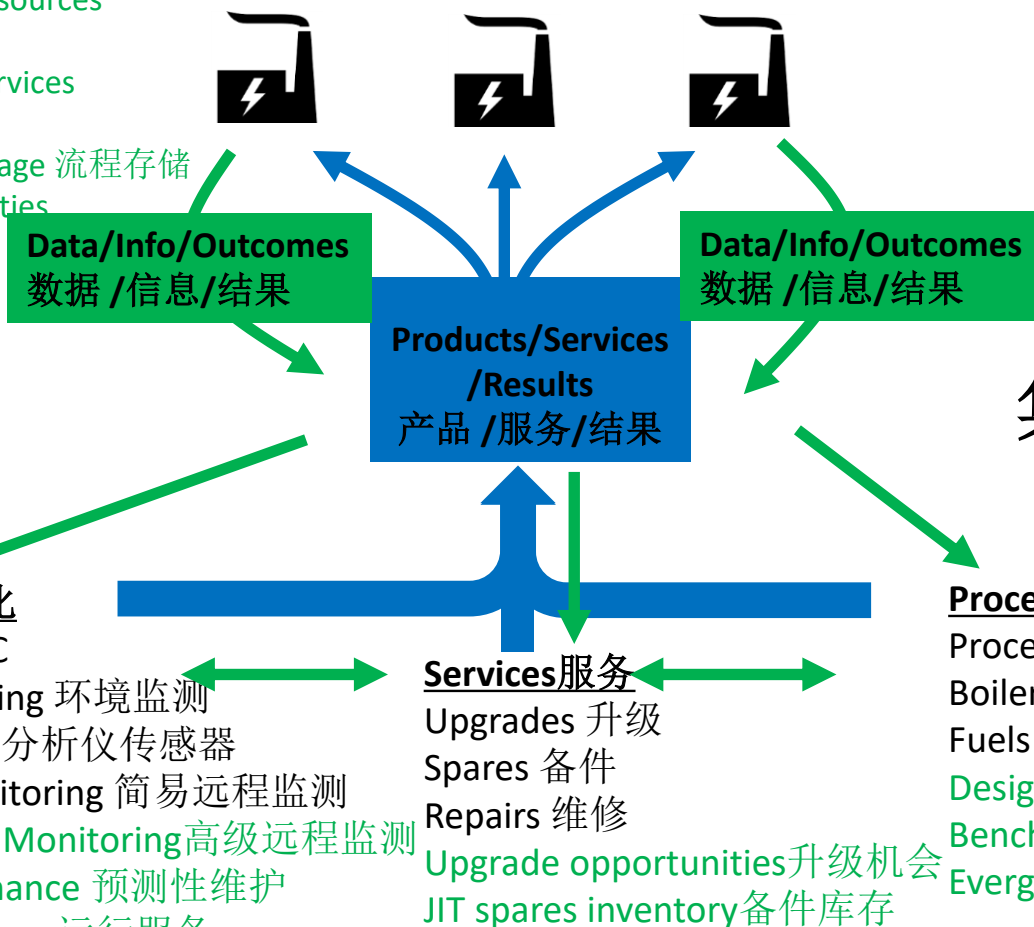
Enhanced Remote Monitoring 高级远程监测

Predictive Maintenance 预测性维护

Performance Services 运行服务

Network Edge 网络优势

Recurring revenues 循环收入



Integrated Products,
Proactive to
Customer
Outcomes

集成产品, 引导
客户需求

Process Technology 流程技术

Process Knowledge 流程知识

Boilers/Technology 锅炉/技术

Fuels knowledge 燃料知识 (实际)

Design optimization 设计优化

Benchmarking 与最优方案比较

Evergreen Design 可持续运行设计

**SureSense:
Remote Monitoring and
Predictive Maintenance
Solution**

远程监测与预测性维护方案

SureSense: Reduces Cost and Risk of Failure 降低成本与故障风险

- Detect an emerging problem **immediately**
立刻察觉潜在问题
- Pinpoint the **cause** of the problem
精准查找问题根源
- Determine remaining **time to act**
确认问题处理剩余时间



How does it work? 原理

- Compare observed behavior to expected behavior

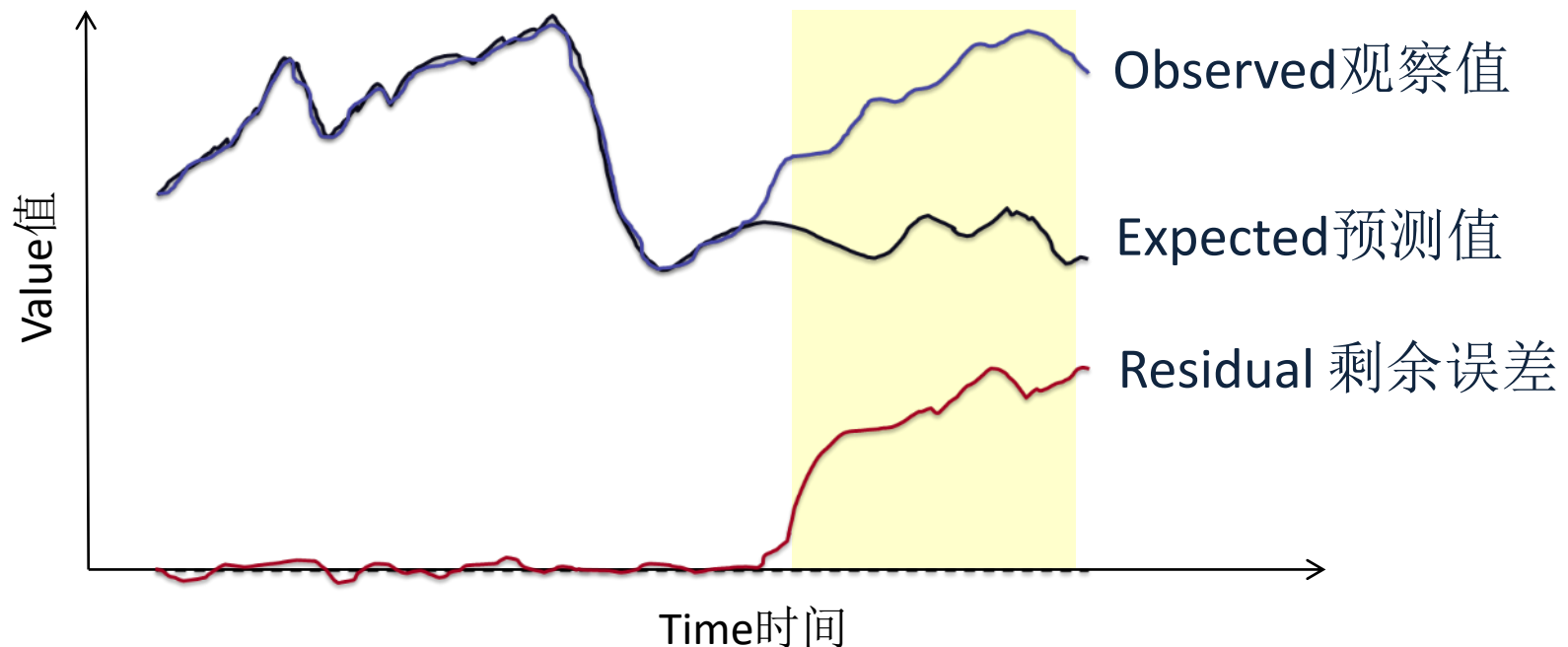
比较观察行为与预测行为

- SureSense provides the **most accurate** expected values

SureSense提供**最准确**的预测值

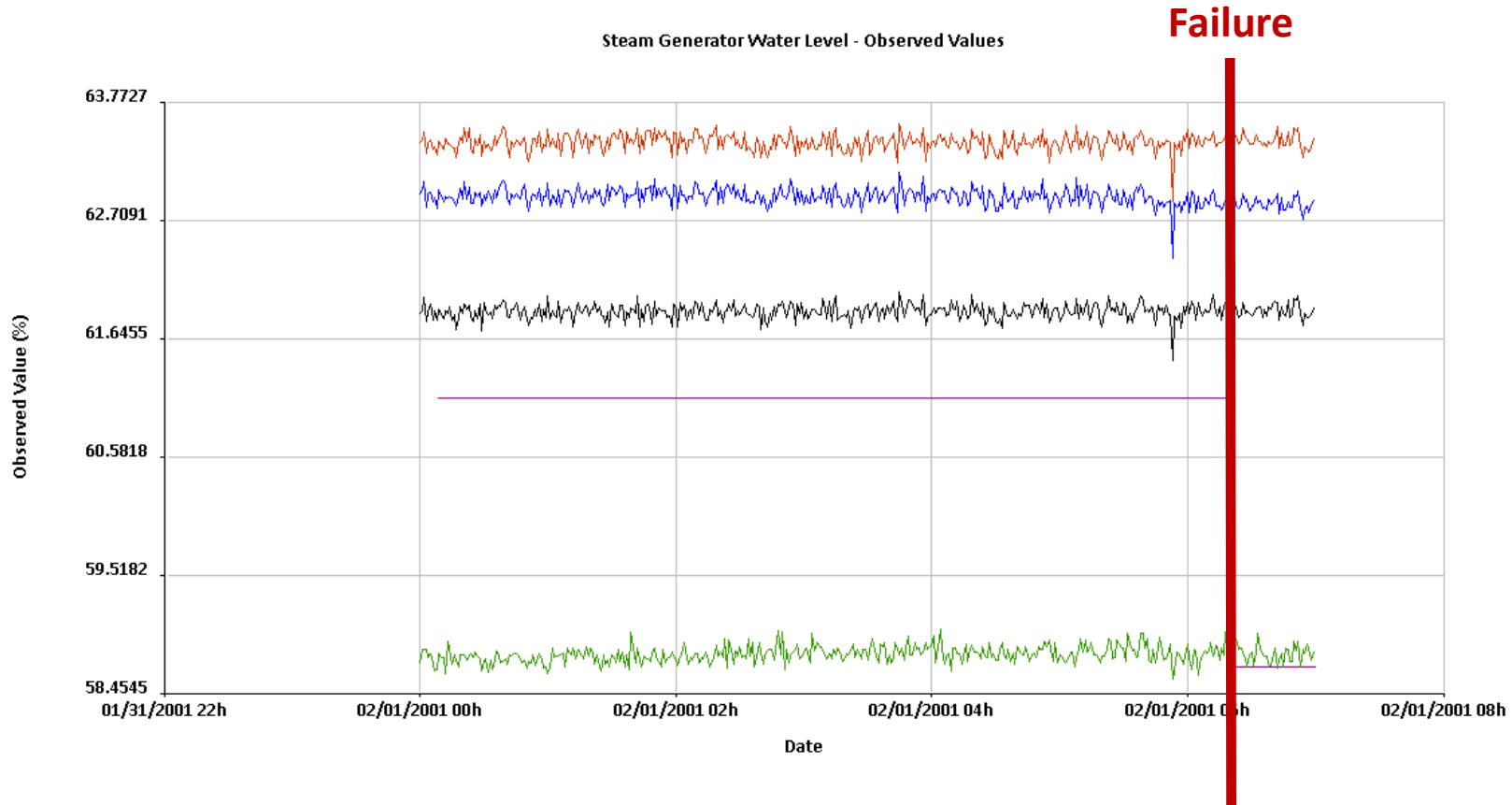
- Results for multiple signals pinpoint the problem's cause

通过比较结果中的多重信号精确查找问题根源



Which Sensor is Failing?

哪一个传感器正在失效？



SureSense: Early Detection of Failing Sensor 提前察觉失效传感器

Detect Problems at the Earliest Time

第一时间发现问题

- Maximize the time to act, minimize the damage
预留更多的处理时间，将损失降至最低
 - **SureSense** will find the problem sooner 更快发现问题
- Highest sensitivity and fewest false alarms
最高的敏感度和最低的错误率
 - Models optimized for each system operating mode
为每一个运行系统最优化模型
 - High performance pattern recognition models
运行规律识别模型
 - Integrate first principle & thermal performance models
集成有限原则与运行表现模型
 - Simultaneously monitors assets from several perspectives:
多角度同时检测设备运行
 - Data driven (mechanical & process) 数据驱动（机械与流程）
 - Physics-based (process & reliability) 基于物理结构（流程与可靠性）

Pinpoint the Cause of the Problem

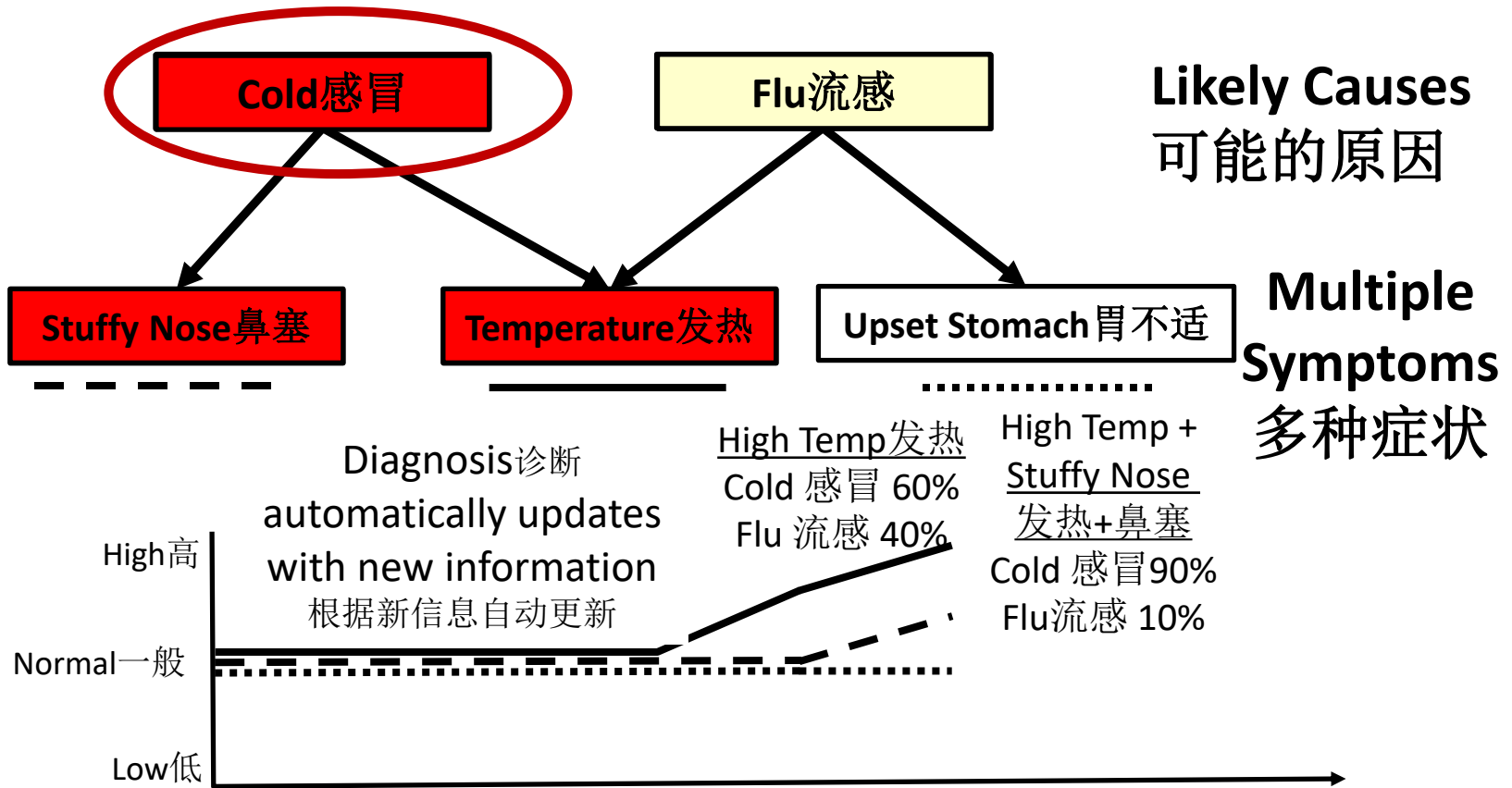
精准查找问题根源

- An **accurate** diagnosis assures the right response
准确的诊断保证正确的措施
 - Many products stop at “detect a problem” 许多产品只停止在“发现问题”
- Model-based diagnostics are most accurate
基于模型的诊断机制最为准确
 - Models use multiple fault (anomaly) detector states to determine the probability of each failure mode
模型通过多个探测器确定每一种故障的几率
 - Best approach for complex failure modes with overlapping symptoms 提供解决问题最佳行动方案
- Diagnosis models bring boiler expertise online
诊断模型将企业的产业经验提升集成至网络平台
 - Capture boiler trouble-shooting and FMEA guides 获取故障记录并存档
 - Automated diagnosis based on real-time monitoring of symptoms 自动进行实时监测
 - Continuously updated with new information 不断更新

Pinpoint Cause using a Diagnostic Model

通过诊断模型精确查找问题原因

- Multiple causes often have symptoms in common
不同原因经常造成同样症状



SureSense Forecasts the Remaining Time to Act

预测还有多久会故障停机

- Knowing WHEN the failure will occur provides the opportunity to avoid it or repair it
知道何时故障会触发将提供预防和维护的机会
- Depends strongly on the cause of the problem 取决于问题原因
 - When will I reach an operability limit? 何时会达到运行极限?
 - When will I need to replace the asset? 何时需要更换设备?
- Online monitoring is an **essential** pre-requisite 在线监测是必要条件
 - Provides degradation parameters to trend over time
提供设备退化参数
 - Provides actual conditions for life consumption models
提供设备在实际运行环境中的使用寿命计算模型

Remaining Useful Life Prediction

使用寿命预测

Reliability-based 平均寿命

Weibull

Mean-time-to-failure

Stress-based 特定情况下平均寿命

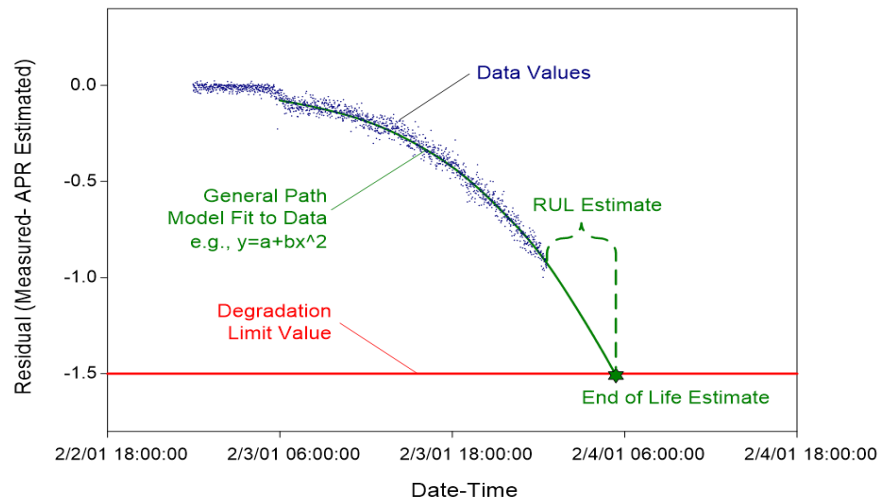
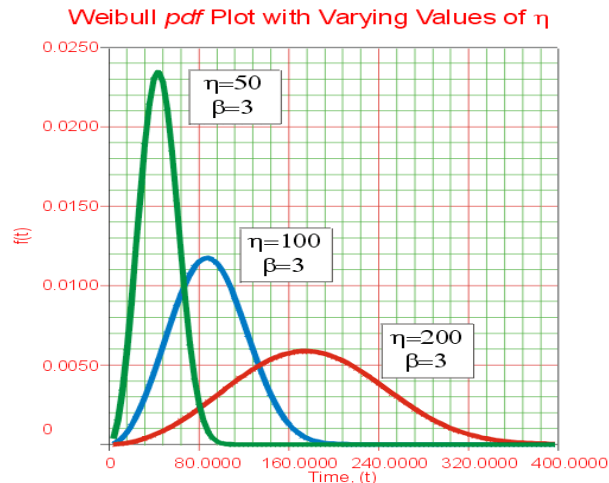
Modified-Weibull

Proportional hazards

Condition-based 特定情况下寿命

Cumulative Damage

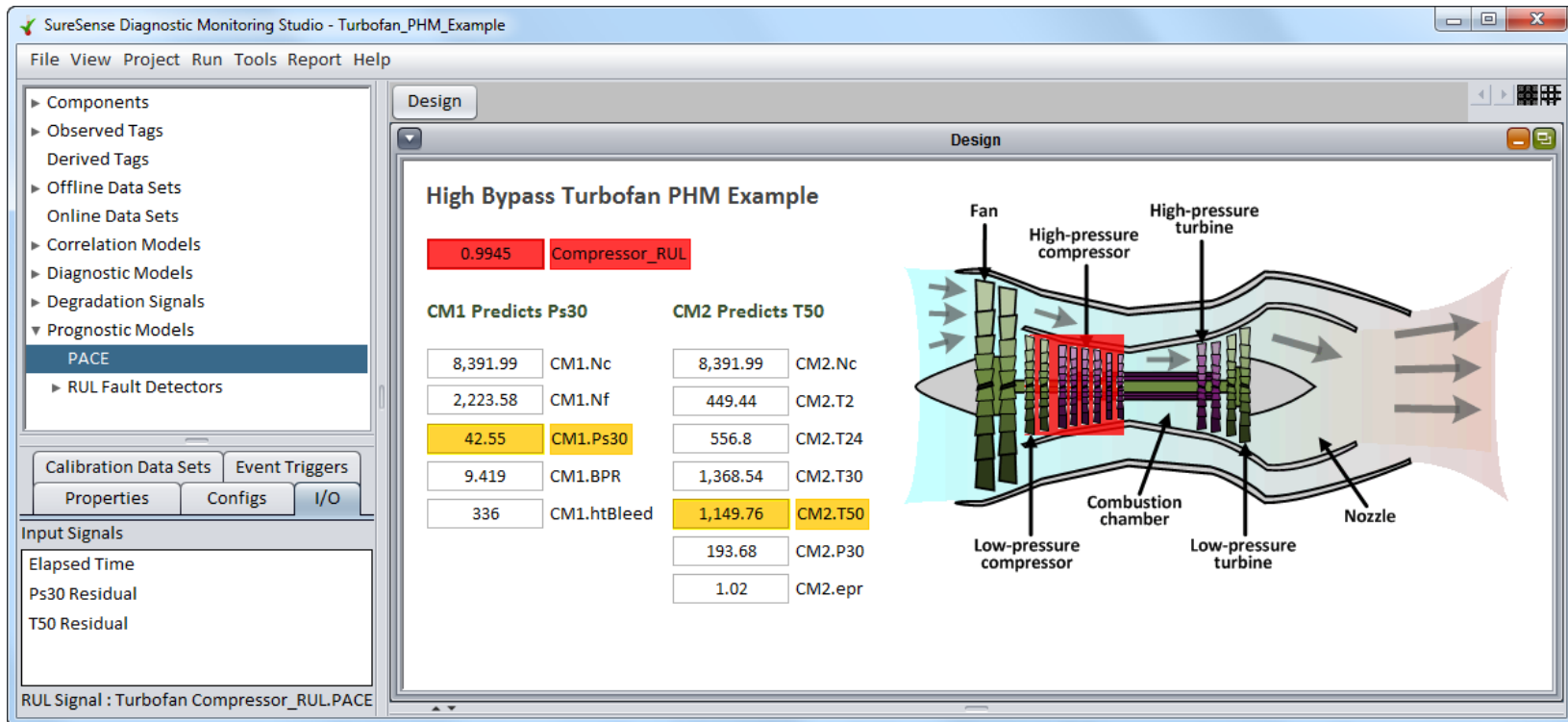
General Path Models



Turbofan Engine Life Example

发动机使用寿命案例

Forecasts flights remaining before maintenance needed 预测下一次维护前的剩余飞行里程

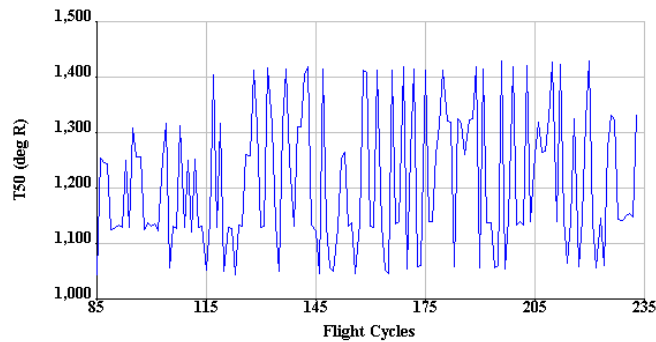


SureSense Predicts Remaining Flights

before Maintenance Needed

预测下一次维护前的剩余飞行里程

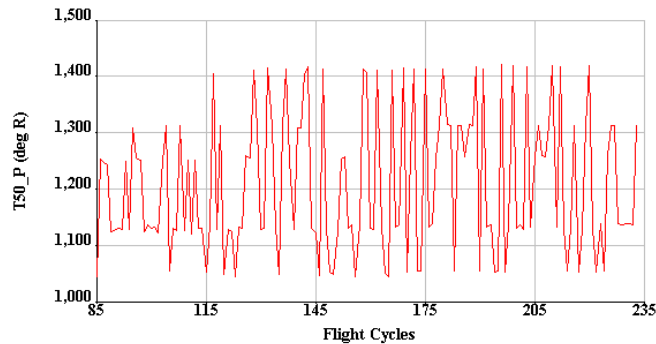
Observed Turbine Outlet Temperature



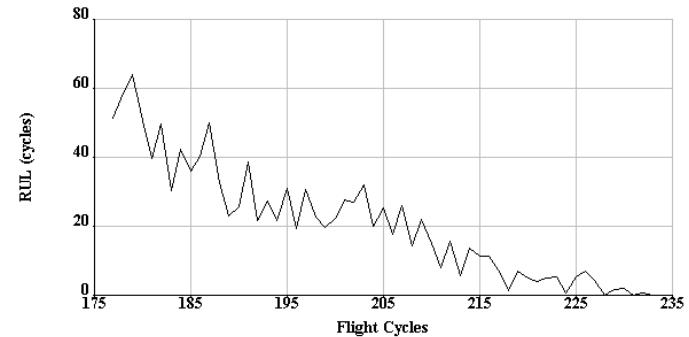
Degradation of Turbine Outlet Temperature



Expected Turbine Outlet Temperature



Predicted Remaining Service Life



Steam Turbine Diagnostic Example

蒸汽轮机故障诊断案例

Sudden drop in generating efficiency 发生效率降低

Problem solved (问题已解决) :

- Detect earliest onset of damage to 1st stage component in high pressure section

发现第一级叶轮出现高压部分部件损伤

- Detect earliest onset of 2nd stage obstruction due to liberated 1st stage material

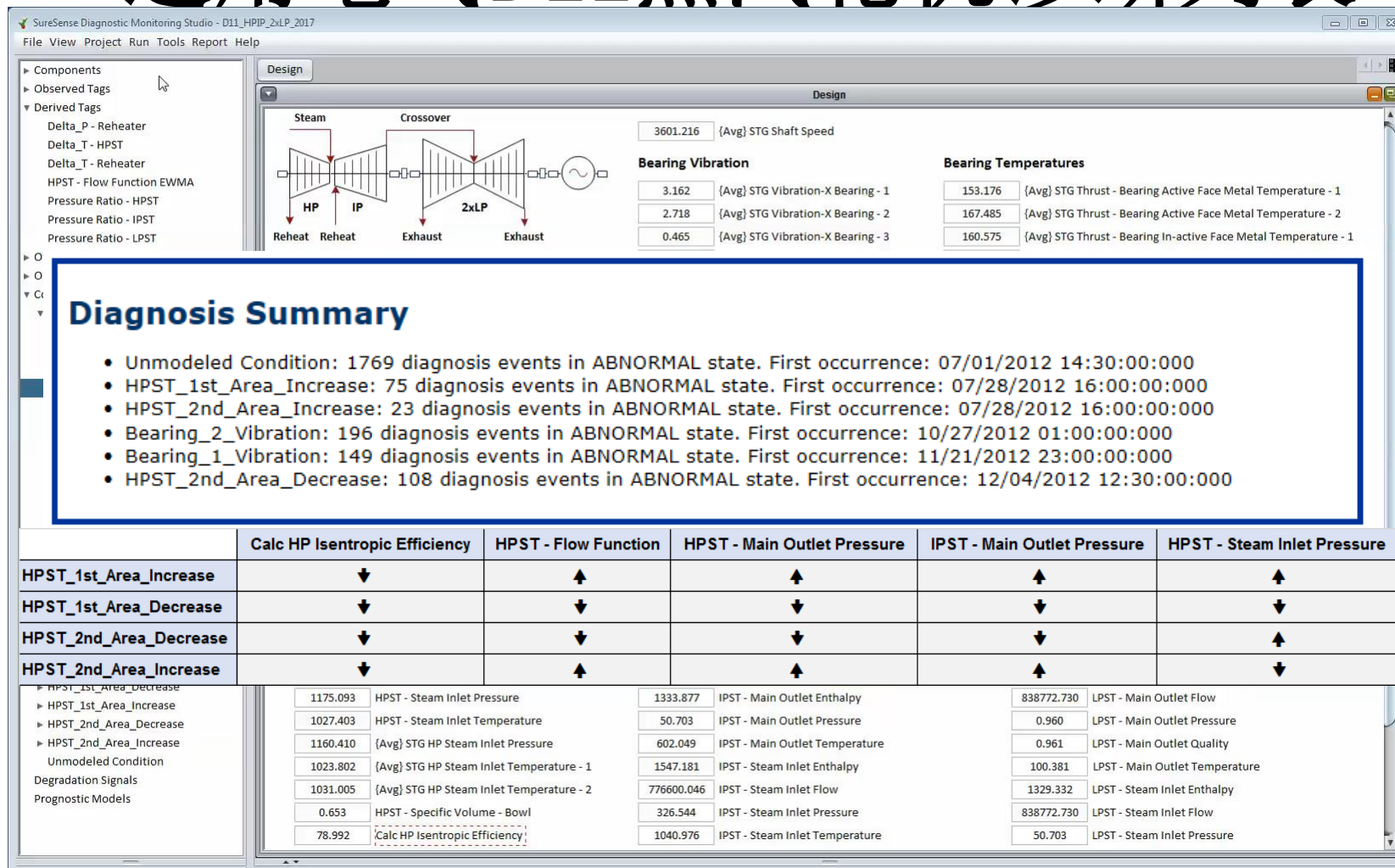
发现第二级叶轮出现障碍 - 由于第一级叶轮故障

- Monitor all performance and mechanical parameters for HP-IP 2xLP configuration

监测所有运行的机械部件参数

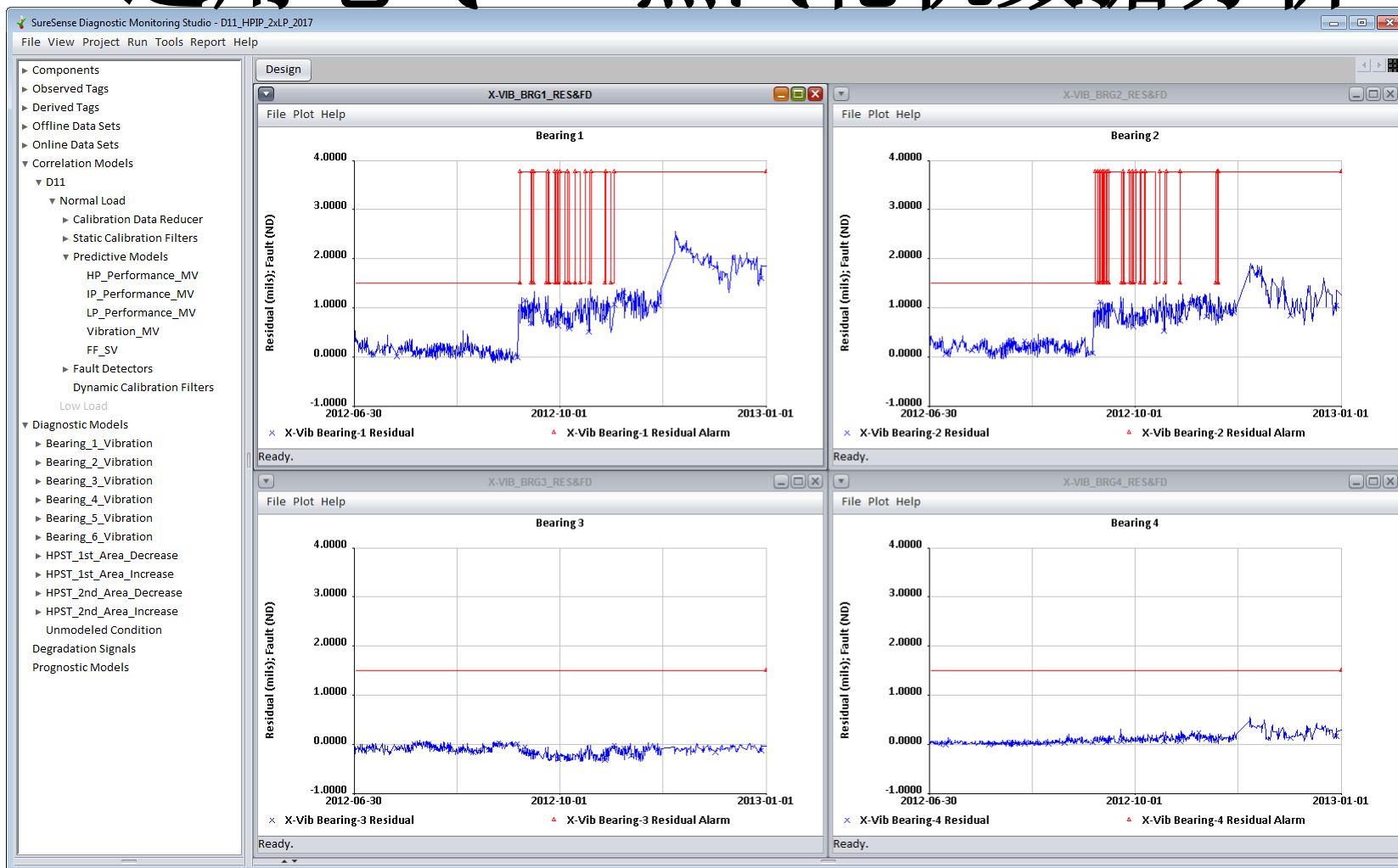
GE D11 Steam Turbine Event

通用电气D11蒸汽轮机诊断列表



GE D11 Steam Turbine Event

通用电气D11蒸汽轮机数据分析



Digitalization Mistakes to Avoid

数字化进程需要避免的错误

- Believing this Digitalization movement will pass
认为数字化趋势很快就会过去
- Adding functionality customers don't want
添加客户不需要的功能
- Underestimating data security risks
低估数据安全风险
- Failing to anticipate new competitive threats
忽视新的市场威胁
- Waiting too long to get started
对做出改变犹豫不决
- Overestimating internal capabilities
过度高估企业现有能力

Conclusions 结论

“The future is already here – it’s just not very equally distributed”

– *William Gibson*

“The only strategy that is guaranteed to fail, is not taking any risks and not changing anything – because the world is moving too fast”

– *Mark Zuckerberg*

Thank You.
谢谢

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