DIGITAL INNOVATION FOR THE HYDROPOWER GENERATION MARKET by GE Renewable Energy - Hydro August 27th, 2018 - Salto Grande workshop on Digitalization

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Digital Hydro Plant ↑ Revenue, ↓ Cost, ↓ Risk

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Fundamentals

Our Approach (to define Digital Solutions)

GE's Hydro APM Success Stories

Final Motivations for Pursuing a Digital Transformation

Cool Links to Have a Look



Fundamentals



Point of Reflection: Some "Digital" Quotes

"By 2021, half of large industrial companies will use digital twins, resulting in those organizations gaining a 10% improvement in effectiveness." (Gartner) "There were 5 exabytes of information created between the dawn of civilization through 2003, but that much information is now created every 2 days." (Eric Schmidt - Google)

"Information is the oil of the 21st century, and analytics is the combustion engine." (Peter Sondergaard - Gartner)

"I never guess. It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts." (Sir Arthur Conan Doyle) "In God we trust. All others must bring data." (W. Edwards Deming)

"Google knows you better than you know yourself." (James Carmichael)

The Formula for the Digital Industrial Applications

Data Continuous, accessible... BIG DATA!

Advanced Data Science



Statistics & Machine Learning Identify trends & anomalies

Applied engineering

Asset & Domain Expertise

Digital Industrial outcomes

One platform for OT & IT teams to collaborate and innovate ΟΤ

IT

Digital Hydro Power Plant and Ecosystem

Business Applications

| Business Optimization | Market Intelligence & Forecasting | Portfolio Optimization | Energy Tra Mana | ading & Risl gement | k Cor | Business nmunications & Financials | |
|------------------------------------|--------------------------------------|------------------------|--------------------------|------------------------|--------------------------|--|--|
| Operations Optimization | Fleet Management | | Advanced Controls System | | | | |
| | Remote Control | Optimal Dispatch | Efficiency | Flexibility | Capacity | Environment | |
| Asset Performance Management | Reliability Management | Asset Strategy C | Optimization | Fie | Field Service Management | | |
| | Machine & Equipment Health | | | | | | |

Enabling Platform

PREDIX

Mobility | Cloud Services & Applications | Security | Software Development Kit



Predix Edge

Optimizing Controls Applications | Edge Analytics | Edge Applications A

Cyber Security

Baseline | Defend | Prevent

Digital Twin

Digital Industrial Transformation Roadmap Overview

⁻undamentals

Get Connected



Centralize data across enterprise Visualize data for insights Enable expedited response and RTS Expert diagnostics + Predictive Analytics Move unplanned to planned maintenance Knowledge Management

Get Insights

Get Optimized

Optimal plans (maintenance, operation etc) Maximize asset life Data based decision making

Conduct Assessment

Identify reliability challenges & improvement opportunities

Validate Business Case

Assess value of improvements

Scope Implementation

Map out implementation & timeline

Our Approach (to define Digital Solutions)



Our Approach



SOME KEY ASPECTS

- Software / utilization
 - ERP's, Editors etc.
- Data collection & storage
- Controls SW, other systems
- Taxonomy
- Asset Mgmt per ISO 55000 / PAS 55 framework
- Org maturity (reliability)
- Decision-making processes
 - F(personnel knowledge)?
 - Data-driven? F(statistics, advanced analytics, AI)?
- Customer own view of the Org & Pain Points vs. Desired status vs. Benchmark

Our Approach – Cont´d

Some working methods/tools

- Starter Kit
- Discovery Session
- DTA Digital Transformation Advisory
- PoC / Pilots

<u>Note</u>: If Customer comes with a specific pain point that he/she wants to address with no discussion, a Digital Application may be identified and deployed. However, it's not the best way to do it, for the sake of securing meeting the expectations in regards to the problem of concern.



GE's Hydro APM Success Stories





Hydro Customers Using GE's APM Solutions



90+ Hydro Plants, 30GW+

Success Story: Reliability Management BC Hydro

Challenges

- Aging hydro power plants (last plant commissioned 1982) approaching end of life – limits on CAPEX to replace and refurbish
- New way to operate plants as peaking plants (from 50 to over 300 start/stop) and as synchronous condenser capacities
- Knowledge transfer issues (workforce made of very senior and very junior engineers, few middle-aged workforce)

GE Solution

- APM Cloud Reliability Management deployed on HPPs over 20MW Track of changes in equipment condition – 9,000 tags monitored w/ 260 diagnostics - automatic priority escalation (5 to 1)
- Help maintenance engineers at generating facilities optimize and plan preventative maintenance

Outcomes

- Early notification of catastrophic failures (USD 200k-1M / year)
- Reduction of forced outages
- Elevate level of knowledge about the plant equipment and its condition
- Optimize maintenance activities (from time-based to condition-based)
- Efficiency gains



Regulated Canadian cleanenergy utility with 95% generation hydro-based, providing 1.9 million customers

32 hydroelectric facilities ranging from 2MW up to 500MW

Total hydro capacity is 11,000MW



CAD 1.5 to 9M saving over a 10 year period on failures caught be GE's predictive analytic.

GE Renewable Digital

Success Story: Reliability Management BC Hydro

Catching a Masked Issue



Problem:

- Advisories post for a step increase in the turbine guide bearing vibrations
- Initial beliefs were related to pre-existing sole plate sticking issue... but cavitation was at stake and vibration measurements were < alarm settings
- Identified vibration behavior as unique
- Actions to avoid failure taken 6 days after the catch



IT's a MIX OF ALL THESE THINGS!

Success Story: Extending TBO = \checkmark MTTR EDSB – Énergie Développement Service du Briançonnais

Challenges

- Extend TBO, reduce Mean Time To Repair (MTTR)
- Accurately determine severity of heated bearings remotely
- Transforming baseload operations to flexible

GE Solution

- APM Machine & Equipment Health with remote, real time connectivity to GE Center at Grenoble, France
- Data acquisition and processing system with 11 sensors and local 3D HMI to process 2 TB data/month
- Automated diagnostics, Useful Life prognostics, and Vib. monitoring

Outcomes

- Precise diagnostics of shaft radial displacement, no shock or rub; likely due to external parameters
- Bearing declared safe; no inspection or machine stoppage
- \$ 5 k of production¹⁾ loss avoidance
- \$ 3.2 k of inspection²⁾ cost avoidance
- ~1% ↑ availability



 Production Loss Avoidance = 2 Days X 24 Hrs X 66% CF X 5 MW X \$ 32/MWh PPA
Inspection Loss Avoidance = 2 Days X 10 Hrs X \$ 80/Man Hour X 2 Engineers TBO (Time Between Overhauls; MTTR (Mean Time To Repair)



Énergie Développement Services du Briançonnais

EDSB is a local electricity distribution company in South Eastern France serving over 11,000 customers.

Point Baldy Hydro Plant operates a 5 MW Horizontal Francis Turbine with 2 guide and 1 thrust bearings, generating 18 MM kWh energy annually, enough to power 3,000 homes Precise Diagnosis that Avoids Losses and Increases Availability

Success Story: Reliability Mgmt & ASO EDP: GE hired to Digitalize the O&M of Energy Production Assets

Challenges

- Improve use & performance of critical power assets (Turbines, Generators...) safely and without degrading forced outage rate (EFOR)
- Improve operational efficiency
- Break company silos by sharing real-time data on power gen assets across Operations, Maintenance & Trading EDP teams
- Build a multi-fleetwide remote monitoring center (Hydro, Thermal)

GE Solution (Hydro)

- **RM Cloud Analytics** deployment to 56 units (25 failure modes)
- Edge Platform deployment to 28 critical units (21 failure modes)
- Pilot for Asset Strategy Optimization (1 HPP)
- Partial load Extension (5 units, Francis & Kaplan) with real time risk hillchart visualization

Expected Outcomes (Hydro)

- Reduce loss of production due to internal causes by 24%
- Decrease preventive maintenance costs by 10%
- Increase revenues from balancing services (grid or portfolio) by 2%



One of the major utility companies in Europe managing 34 hydroelectric facilities, 9 thermal plants in Portugal and Spain Totaling 6,500MW hydro and 5,800?Z gas and coal capacity

An Extensive Contract Covering a Large Range of Assets

A Landstreen



Success Story: ASO – Asset Strategy Optimization Dashboard Samples (HMIs)



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Final Motivations for Pursuing a Digital Transformation



US Retailers Value Growth in 10 yrs

| COMPANY | MARKET VALUE 2006 | MARKET VALUE 2016 | % CHANGE |
|-----------------|----------------------|----------------------|-----------------|
| sears | \$27.8B | \$1.1B | ~ 96% |
| JCPenney | \$18.1B | \$2.6B | ₩86% |
| NORDSTROM | \$12.4B | \$8.3B | ₩ 33% |
| KOHĽS | \$24.2B | \$8.8B | ₩ 64% |
| ★macys | \$24.2B | \$11.0B | ₩ 55% |
| BEST | \$28.4B | \$13.2B | ₩ 54% |
| O TARGET | \$51.3B | \$40.6B | × 21% |
| Walmart 🔆 | \$214.0B | \$212.4B | × 1% |
| amazon | \$17.5B | \$355.9B | № 1,934% |
| | | | |



Source: Yahoo Finance (peak value in 2006), Google Finance (values for Dec 30, 2016)



Hard Skills by Linkedin

PRESENTED BY LINKEDIN LEARNING

1. Cloud and Distributed Computing 2. Statistical Analysis and Data Mining 3. Middleware and Integration Software 4. Web Architecture and Development Framework 5. User Interface Design 6. Software Revision Control Systems 7. Data Presentation 8. SEO/SEM Marketing 9. Mobile Development **10. Network and Information Security 11. Marketing Campaign Management** 12. Data Engineering and Data Warehousing 13. Storage Systems and Management **14. Electronic and Electrical Engineering** 15. Algorithm Design 16. Perl/Python/Ruby **17. Shell Scripting Languages** 18. Mac, Linux and Unix Systems 19. Java Development 20. Business Intelligence 21. Software QA and User Testing 22. Virtualization 23. Automotive Services, Parts and Design 24. Economics 25. Database Management and Software

Cool Links to Have a Look...



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- <u>https://www.ge.com/digital</u>
 - Resource Center & Etc.
- http://www.geautomation.com/catch-of-the-week
- <u>https://www.youtube.com/user/industrialinternet</u>
- <u>https://www.youtube.com/user/MeridiumAPM</u>

THANK YOU!





imagination at work