

Introduction

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(Bailey Controls 1978, 27+ years in this field)

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Personal Profile

- Former electrical engineer, bits-and-bytes designer/programmer
- Former Power Generation Energy Efficiency Product Manager
- Seven US patents: Internet connectivity, Asset Management, Power Plant electrical systems
- Now a self-styled “prognosticator” & “big picture” guy - examples:
 - Coal to Gas power paradigm shift (2009 - present)
 - Atmospheric CO2 growth models (begun in 2007)
 - AdvancedProjections.com (2013 - present)

The Big Picture in Power

- The situation today is very much market driven
- “Traditional” power generators are psychologically and fiscally risk averse from an operational view, as technology failures leading to trips and outages may cost million\$\$\$
- ISOs/RTO's & Generators view reliability as a “10” and energy efficiency as a “2” on 1-10 scale
- In regulated markets, PUC restrictions and the new tax laws are actually reducing available cash for upgrades and improvements

Big Data 1

- It's there, in plant data historians: days, weeks, months, perhaps years of operating data
- You don't have to undergo huge and complex analysis to uncover issues of financial importance to O&M
- Restricting scope for individual topics saves from being "overwhelmed" at first by Big Data

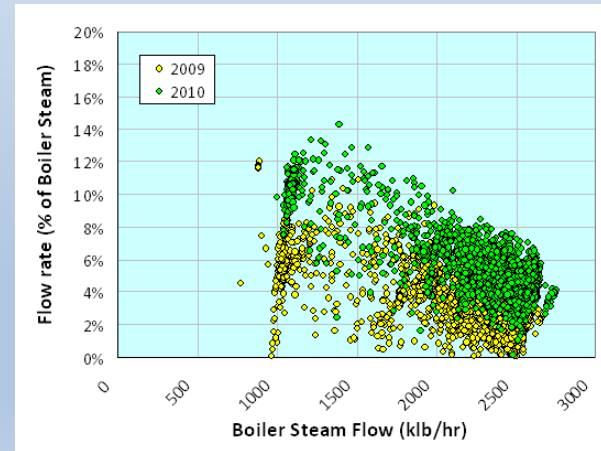
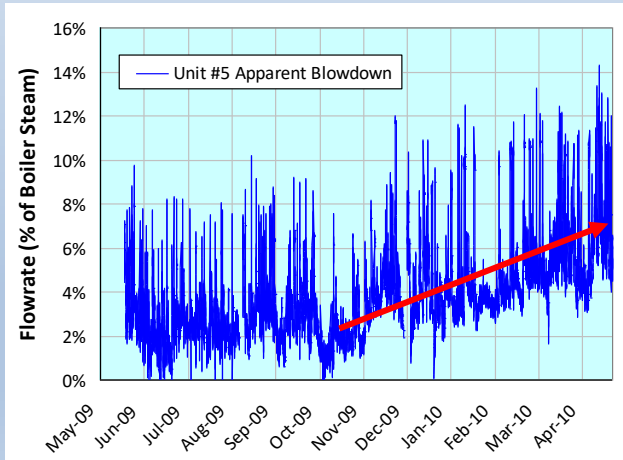
Big Data 2

- **Basic “Quick KPI” analysis to begin**
- **Focuses:**
 - Revenue sources/sinks
 - High probability events identified in NERC GADS*
 - HILP events: High Impact Low Probability
- **Examples:**
 - Ancillary services: Load & Frequency responses
 - Plant Efficiency & Performance
 - Water consumption
 - Machine condition
 - Loop performance and tuning

*Tube Leaks!

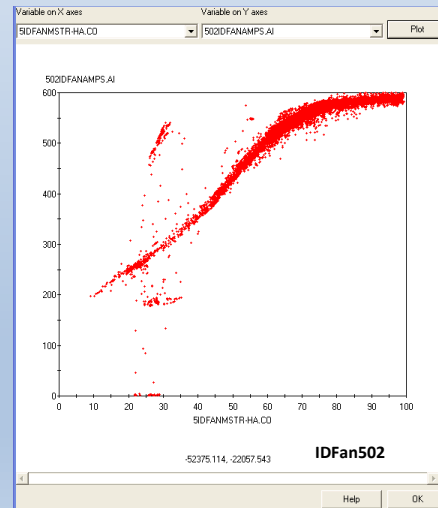
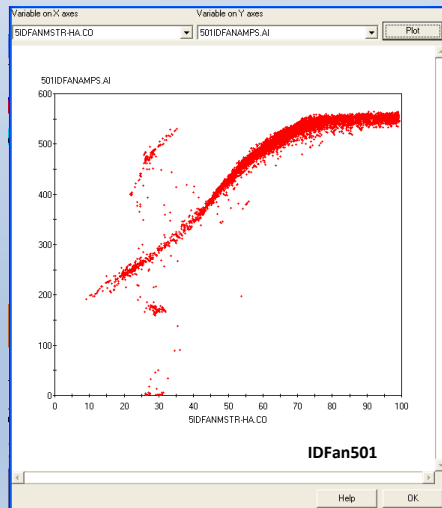
High Return Examples

- Case: Calculated water use moves from 3% to 7% in 6m
 - Cost of makeup water + energy losses
 - At the time of discovery, loss rate **\$2M/yr** and climbing



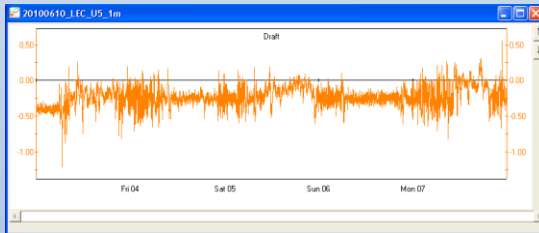
High Return Examples

- Case: ID Fan Efficiency Loss
 - Cost of top end of load, aux power consumption
 - At the time of discovery, loss rate was **~\$350k/yr**

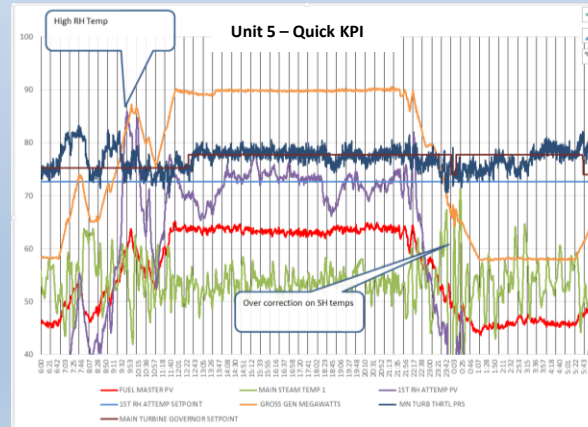


High Return Examples

- Case: Control Loop Performance & Tuning
 - Cost of performance loss, operational “dances” to compensate, inability to ramp at 3%/min, or to make rated load
 - At the time of discovery, loss rate exceeded **\$500k/yr**



Furnace Pressure Excursions



Boiler Tuning Required

Automation Speeds of Response

- Safety & process protection
– Milliseconds to seconds
Automated “reflexive actions”
0.001 to 100 sec
- Process/equipment O&M
– Seconds to hours
Auto & Manual “Tactics”
100 to 100,000 sec
- Enterprise/Fleet management
– Hours to Months
Automation of “strategies”
10,000 to 100,000,000 sec

When automation is better

- Instances where reaction time is faster than people can respond.
- Ongoing control with highly simultaneous and repetitive characteristics (plant controls)
- Data mining, deep pattern recognition where information is collected over widespread populations and long periods of time
- People are slow compared to timescales required for accurate process controls and equipment safety.
- People have limited bandwidth and quickly experience situational fatigue, but can supervise operations with help
- Limited bandwidth & capacity
- “Algorithms” are subjective/intuitive
- Attention span is limited due to “watching paint dry” syndrome

INDUSTRIAL IoT DATA PROCESSING LAYER STACK

Source: WinSystems

CLOUD LAYER

Big Data Processing
Business Logic
Data Warehousing

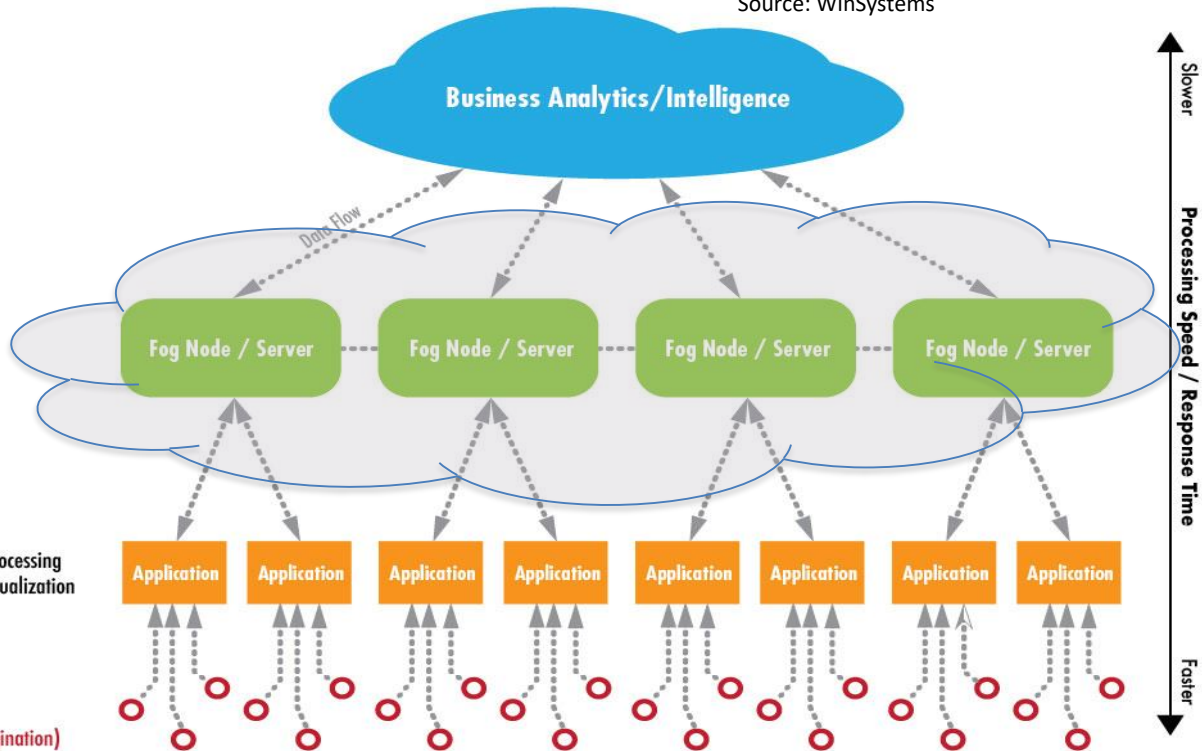
FOG LAYER

Local Network
Data Analysis & Reduction
Control Response
Virtualization/Standardization

EDGE LAYER

Large Volume Real-time Data Processing
At Source/On Premises Data Visualization
Industrial PCs
Embedded Systems
Gateways
Micro Data Storage

Sensors & Controllers (data origination)



This “fog” layer is where we work and live!

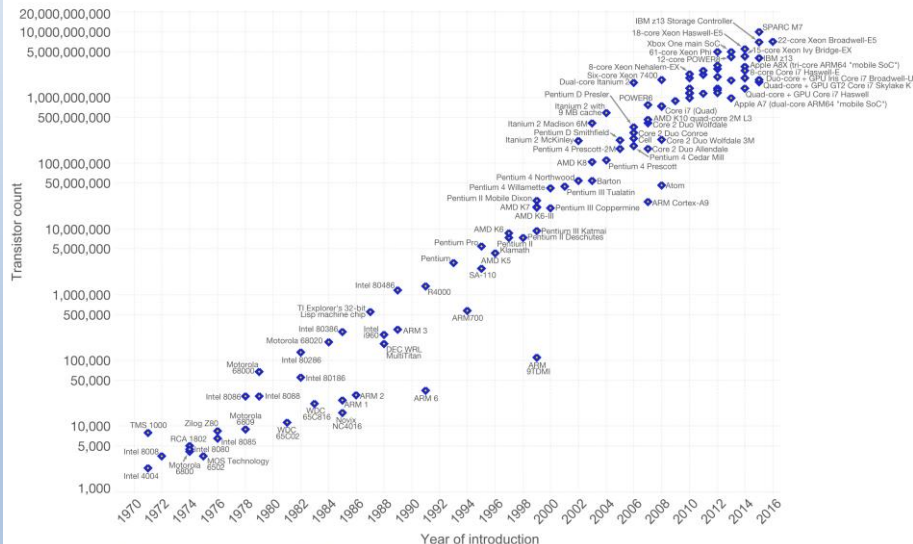


Evolution of Computing Power

Moore's Law – The number of transistors on integrated circuit chips (1971-2016)

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.

Our World in Data

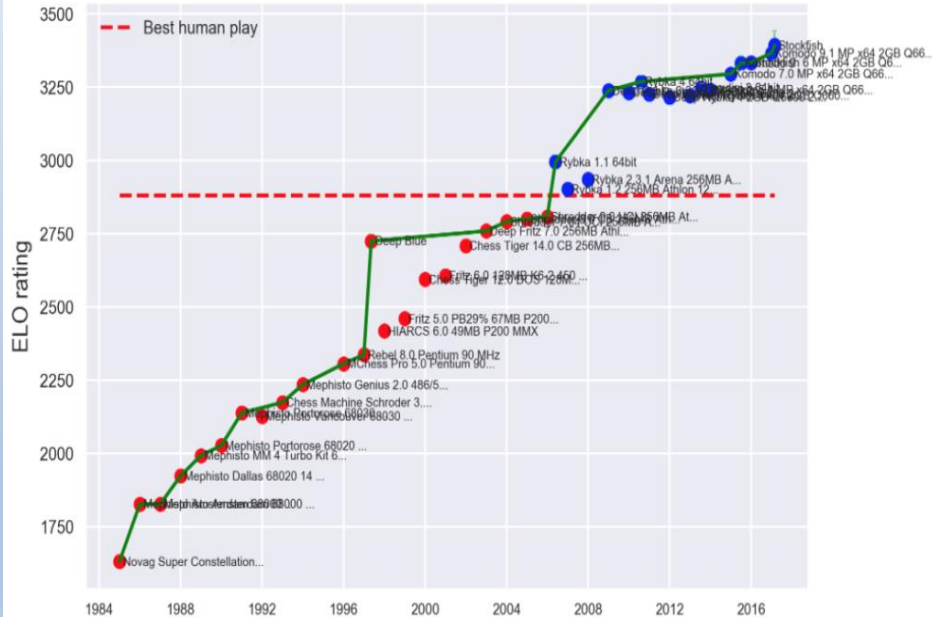


Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)

The data visualization is available at OurWorldinData.org. There you find more visualizations and research on this topic.

Licensed under CC-BY-SA by the author Max Roser.

Computer Chess



Big Data Analysis isn't free, but it pays for itself!

- Manual data harvesting and investigation of unit history
 - \$50k to \$100k
 - Untargeted “studies” often prohibited by state regulations
- Setup for remote monitoring of current data and trends has about the same cost as above. Add to this the annual cost of data monitoring and mining through collaborative operations.
- Luminent Power of Texas claims \$500M in savings over a decade through internal 24/7 collaborative operations center (Dallas), with costs of a small fraction of that, yet plants are still being closed.
 - No capacity market in ERCOT, unwilling to pay for non-spinning reserves
 - May 2018: some day ahead prices exceeded \$500/MWhr
 - May 2018: some real time energy exceeded \$3100/MWhr