Usage of technology for automating an industrial environment.

Automation and Technology, Where we've come from, Where we are

Where we will go. The needs for it, and its effects.

Plant Maintenance/Building Automation

AERBURN ENGINEERING + CONSULTING

Peter Barhydt
AerBurn Engineering and Consulting

Presentation to IPE Chiefs Meeting

Plant Maintenance /Building Automation

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AerBurn Engineering and Consulting

AerBurn Engineering and Consulting Limited is an engineering company working in the Steam and Heating Plant industry as well as combustion applications.

AerBurn's customer focus is through direct customer contact, participation in professional user groups such as the Institute for Power Engineers, and active memberships in code development in Canada.

Principals Rob Marr and Peter Barhydt, each have over 25 years of experience in steam plants and process control. Peter is a longtime member of the IPE and is a member of the CSA Fuels Field Approval Code B149.3–15 committee. Rob is a member of the TSSA fuels division user risk reduction group.

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AerBurn Engineering and Consulting

General Information Studies and Audits include:

- TSSA and CSA Compliance
- Boiler Repairs and Life Expectancy
- Emissions Reduction
- Emergency Boiler Replacement and Overall Risk Reduction
- Heat Recovery Sinks and Sources

AerBurn Engineering and Consulting

Engineered Projects and Consulting Services include:

- TSSA / CSA upgrades and Field Approvals
- Equipment Specification, Bid Review and Selection
- Burner Retrofits for Fuel Conversion, and Increased Efficiency,
- Control System and Burner Management System Upgrades
- Flue Gas Heat Recovery for Boilerhouse Efficiency

Usage and type of technology for automating an industrial environment.

- We can trace where we are by looking at the evolution of our industry with respect to Fuel systems, I & C , and Communications
- There are now new pushes in technology
  - We must use them effectively

Boiler and Fuel Evolution

Boiler evolution-starting in the fifties: Coal Firing, Pneumatics Era

- Coal
  - Coal has more Radiant energy
    - Water tube Boilers were shallower, wider, taller
    - Firetube Boiler had Fireboxes, not Morrison Tubes
    - Shipping was tougher – many boilers were constructed on site
  - Traveling Grates and Stokers were common (Pulverizing was costly)
  - Fuel delivery, ash handling systems were the largest maintenance items
  - It was necessary to have more people in the Steam Plant

Boiler evolution-starting in the fifties: Coal Firing, Pneumatics Era

- Burner Management Systems don't exist
- Measurements include; Temperatures and Pressures, Steam flow, Water Level
  - You can't measure coal delivery rates well—NO FUEL FLOW
  - No Fuel Air Ratio Control

Changing Fuels – from coal to oil resulted in a reduction in manpower

- Boilers changed to oil
  - Usually #6, which had to be heated
  - #Lighter oils were cleaner but expensive
- Measurements: Temperatures, Pressures, Steamflow, Water Level AND FLOW
  - #4 and lighter oils could use orifice plate/differential pressure flow measurements
    - Fuel Air Ratio Control being implemented,
  - #6 (higher viscosity) needed other (less reliable) technologies

Changing Fuels – from coal to oil coincided with more sophistication

- Controls - Pneumatic and coming into electronic (more really electric):
  - Oil Flow and Combustion Air Flow controlled by jack-shaft or by operator
  - Combustion Efficiency and Excess Air a bigger topic
  - Cross-Limiting implemented—This is the next big issue in removing controls from operators
  - Burner Management and FLAME SCANNING imperative

Changing Fuels – to Natural Gas

- No fuel delivery issues
  - No conveyors, screws, rams, grates like coal
  - No Tanks, no off-loading like oil
  - No pumps,
  - No heating sets for #4, #6 oils
- No gun cleaning
- Operators love it

Currently

- Natural Gas used by over 95% of Boilers
- Coal restricted to Power Plants
- Heavy Oils became scarce in supply

- Controls became cheaper
  - Electronics gets cheaper every year
  - O2 trim on boilers economical even below 20KPPH
  - Cross limiting implemented on boilers even below 10KPPH.
  - Linkageless Control replacing jack-shaft

Boiler evolution

- Implementation of Forced Draft systems, along with improved Water treatment-- Tubes became smaller
- Better welding technology meant more welding, --membrane walls replaced tangent tubes
- Boiler construction uses less and less refractory, no longer external gas-tight seals

What is important to us?

Coal – Natural Gas	Reliability	Trust	manpower?	Information availability
Flow measurements	XX	XX		XX
control cross limiting	XX	XX		
Flame scanning				
burner mgmt	XX	XX		X

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Instrumentation and Control Evolution

Instrumentation & Control evolution-starting in the fifties: Coal Firing

- Coal with Pneumatic measurement and control
  - Valve Positioner, the “governor” already exists
  - Logic is done through pneumatic relays
  - There used to be Many Vendors
    - Boiler specific--Bailey, Hayes, Republic, Cleveland
    - General--Taylor, F&P, L&N, Moore, Beckman
  - Control is via Panels—mostly on the floor

Instrumentation & Control evolution-starting into the sixties, early 70's

- Burner Management Systems need Electric Switches, Flame Scanning
- Evolving from Pneumatics to electric
  - Thermocouples first electric stuff used, then primarily switches for
    - BMS
    - Alarms
  - Better primary devices are developed
    - Better dPs, cones, annubars, averaging pitot tubes
    - Viscous Flow measurement a problem
  - Automatic Level control
    - Adjustable setpoints available to the operator, no more thermo-hydraulic,
    - 2 element available

Automating an industrial environment.

A Timeline of Steam Plant Technology—Burners and Controls

Era	Fuels/Burners	I & C implementation
1950's	Coal	Valve Positioners Pneumatic Transmitters, Controls
	Heavy Oil	Electric Switches for Interlocks
1960's		
	Light Oil	Electric Pressure, Temperature transmitters
1970's	Natural Gas	Flame Scanners
	Low HP Burners	PLCs, Computer Based Controls
1980's		Electronic transmitters, incl P,T, F
		DCS,PLC,
	Low Emission Burners	
1990's		New Flow Measurement technologies, Mag, Coriolis
		New Communications
2000's	Lower Emission Burners	
		Wireless
Present		

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Then came electronics—70s and 80s

- Transmitters for T, P, L, FL—Magmeters big-but not on Feedwater
- Emissions analyzers available, chosen for “fix-ability”
  - Predominantly O2, Opacity, some Combustibles
- DCS complete with Proprietary Consoles
  - Controller displays are mostly FacePlates, and Alarm Panels
  - The control room a necessity
- PLCs show a cost advantage, develop subroutine flexibility
  - But users worry about one-of, non-standard stuff (programming nerds)

Electronics are everything—80s and 90s

- Coriolis flow available
- Machine health a topic—Vibration Monitoring
- Redundancy for Availability, Reliability
- Networking important—but with proprietary protocols
- Standards become important
  - Control language standard IEC 1131-3
    - PLCs implement early, gain market share from DCS
  - Electrical standards
  - Communication standards
    - RS232, RS422, RS485, Modbus, Modbus RT

Closing out the Century-------1

- COSTS COME DOWN
  - PLCs more common than DCS
  - PC based HMI now standard—Windows SW offered
- HMIs more effective
  - Graphics more useful
    - Dependence on FacePlates reduces to image actuation
    - Time stamping , Cause-of-Trip offered
- Safety Systems introduced
  - Secure Software, Secure Communications

On to 2015

- Wireless-for monitoring first
- Safety PLCs offered by many
  - Codes request Safety PLCs
- Compensated Flows
  - Tighter control
- Analog measurements accepted for safety
  - Analog transmitters can show health rather than switches
  - Moving to 24 Volt systems, Low Voltage preferred for safety
- Asset Management being promoted
- Smart Alarming—Alarm Standard (ANSI/ISA-18.2-2009)
  - Conditional, Shelving, Density concepts available

What is important to us?

Instrumentation and Control	Reliability	Trust	manpower?	Information availability
diagnostics		xx		x
vibration analyzers	xx	xx	x	
asset mgmt.	xx	xx	x	x
accurate F, P, T measurements	xx	xx		
alarm mgmt		xx		x
wireless				x
safety PLC	xx	xx		

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Communication Evolution

Communications not an issue —it doesn't exist early on--

- 50s into the 60s Pneumatic Controls Era
  - Communication by telephone, teletype, telex
  - Reports hand-written, copies are carbon-copies
  - Trends on paper,
    - Arguments about circular charts versus strip charts
- 60s into the 70s
  - Electronics introduced—measurement and computation
  - FAX machines introduced –Technology for MODEMs

Communications --still not an issue

- 70s into the 80s
  - Copy machines become widespread, Fax machines everywhere
  - Electric devices are becoming popular for measurement
  - BIG Computers are used for control
  - PLCs become more common (Programmable Logic Controllers)--Standalone
  - DCS emerge
    - Distributed Control Systems have proprietary communications
    - “Foreign” Communication via RS232 (point-to-point communication)

Communications becomes an issue

- 80s into the 90s
  - Personal Computers become widespread
    - DCS loses proprietary Operator Consoles
    - Laptops are featured technology (with their own interface issues)
- Communications now an issue
  - RTUs in SCADA systems (typically Oil Field issues) become MODEM sophisticates
  - DCS, PLCs, integrate outside technologies; RS232 widespread, followed by RS422, RS482 and ETHERNET

Communications becomes an issue

- 80s into the 90s—cont.
- Control Vendors try to control Communications with proprietary systems (ring structure versus star structure, token passing, redundant networks, overhead discussions etc.,
- Home market is OVERWHELMING and Ethernet introduced and adopted by the control marketplace. *Non-proprietary now has an edge*
- IT now a player in a Steam Plant

Communications is just an issue

- 90's into the 2000's
  - PLCs and DCS become interchangeable
  - More Vendor Consolidation
  - PLCs are Systems—Complete with HMI
  - DCS are user friendly
    - Control standardized world-wide –IEC 95611
  - Data is more rugged
    - Capture becomes a feature – Oil Systems Pi
    - Data Compression and Reconstruction an issue - - - - "TRENDS"

Communications is now a BIG issue

- 2000's into the 2010's
  - Ethernet now Everywhere – *Controls on Open Networks*
  - Cost of control Hardware reducing steadily
- Transmitter communication now the fight
  - Non-proprietary at a transmitter bus level
    - Hart, FieldBus, ProfiBus
    - WIRELESS
- Why have Controllers at all?—ONLY FOR CONTROL-Not Data

- With cost of control down, lower cost transmitters
- We have a <u>Saturation of controls and measurements</u>

What is important to us?

Communications	Reliability	Trust	manpower?	Information availability
All Controls on open networks	NN			XX
PCs in the Steam Plant	XX			XX
Transmitters on non-proprietary busses	NN			XX
Control and Measurement Costs down	XX			XX

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Where are we now?

What are the significant results of New Technology?

- What Technology is Available
- What do we need?

Where must we go?

Results and Effects of technology – to date

- Benefits
  - Higher Safety,
  - Higher Efficiency,
  - Lower Cost to produce power
- Reduced human liabilities as *Automation mimics the best operator*
  - Less BAD decisions, Less GOOD decisions LESS HUMANS MAKING DECISIONS
  - Technology has enabled management to change to the minimum requirements of staffing involved in the registration of a plant

Results to-date
----------from this technology

- Our Remaining Operators have
  - More Effective control areas-Can see more, more easily
  - More Remote Responsibilities—second control rooms
  - Building Security now often the operators responsibility

Results -- Human Machine Interface --HMI- *What do we look at?*

- Inside the Control System—
- We *USED TO HAVE* dedicated, proprietary Consoles---MMI
  - Showing faceplates, graphics trends, alarm screens
- *NOW* we have PC based Operator Displays---HMI
  - Showing faceplates, graphics trends, alarm screens

NOT MUCH DIFFERENCE

Results - Human Machine Interface HMI-what do we look at

- Outside the Control System
  - Monitors and Video Cameras

MUCH CHEAPER NOW

Results - We don’t want

- Reality is Our people are 2, 3 and 4 technological levels behind
  - Core operators--1sts and 2nds are well over 50**
  - In 15 years it will be corrected
- Reducing manpower has equalled making them very stationary
  - Everything is on the screens
  - It is the evolution of a sedentary lifestyle AT WORK

**ELECTION DEBATE Example

Results -Vendor Saturation

- With lower cost of implementation we have LESS $ spent per project
- PLUS a shrinking manufacturing base - Less Customers and Smaller $$

What do our Automation Vendors Do?

- LEAVE—We have Continual attrition of Vendors since the 60s
- Look for ANY business--Automate lower cost-saving projects—”the big fish are all taken”
- If you can’t sell old tried and true stuff----Sell NEW stuff
  - WIRELESS

How are we making our positions more effective on-going?

- Unorganized effectiveness
  - Unconsciously improving and efficiently reducing the stuff we look at, getting to know the plant—using our FAVORITE SCREENS
- Purchased but ***MOSTLY UNUSED***
  - Trends and Data Storage
  - Optimizing Packages
  - Reports
  - Taking advantage of other PC Programs—Who has put other productive Software on the same PCs??

What are the NEW issues we must face

- New issues within our systems
  - Security of the Boilerhouse, Plantwide system and DATA an issue
  - Off Site Data and support SW “Apps” to use

What area the NEW issues we must face

LEGISLATION

- In 2009 National Public Safety Advisory Committee of Canada (NPSAC) requested that a national
- ***There is to be a*** rationale applied to the technologies of Steam Prime Movers, Refrigeration, and Compression in order to provide a national standard.

There will be ***Risk Factors*** in the Ratings of Plants

Five risk factors.

1. Total Installed kW Capacity (Steam & Water).
2. Single or Multiple Boilers
3. Number of Boiler Rooms
4. Boiler Type
5. Fuel Type

.

We will be mitigating these with Technology

Five risk factors.

1. Total Installed kW Capacity (Steam & Water).
    1. We are doing this already with Either/Or situations
2. Single or Multiple Boilers
3. Number of Boiler Rooms—How Remote is Remote?
4. Boiler Type
5. Fuel Type

They do NOT include Technology

The quality and quantity of this should be the 6th and 7th.

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- Can risk factors change dynamically so that a change in status happens dynamically?
  - If a second fuel is an increase in risk –WHY DON'T WE put 2nd fuels in abeyance while a second boiler is removed from service in order to remain a 3rd class plant? (or 4th class or 2nd class)
  - We already have plants that change dynamically
    - first class on weekdays and second class on weekends
    - First class 6 months and second class for 6 months

We never seem to have

- Many arguments with the Chief Engineer on automating basic information logging
  - Putting the operators logs into the system

Where will we go?
MORE INFORMATION

- MORE Measurements
  - Measurements are cheap
- Different Transmitters
  - Btus in Gas, Btus in Steam, NOx
  - WireLess
  - Low Voltage—low voltage is safer
- More Pictures
  - Cameras are real cheap
- WHY HAVE CONTROL ROOMS
    - Walk around technology is available and can be used

Where will we go?
BUILDING AUTOMATION

- Building Automation Systems will merge with Control
  - Jurisdiction will be interesting
  - Boilers HIGHLY REGULATED--Building Automation unregulated
- Cheaper

What Technology is available ?

Asset Management Software-important machinery is monitored

Expert Systems—using Logic to make decisions
Wireless Transmitters
Video Camera touring of the plant-

Cell phones, Tablets as tools
Laptops as tools
Alarms Logged forever—Requires better alarming
PC Based Reports sent to our emails
Manuals for our equipment on the PCs
Trends—Logged “forever”
PC-Monitoring Stations—Where familiarity of Windows is a requirement.
Pagers
Operating Engineer Minimum Data Collection—what is the minimum by law.

INFORMATION TECHNOLOGY

What Can We do?

- Handle information better
  - Reports sadly lacking
  - Implement smart alarming—standard exists
  - Preventative maintenance now exists at lower cost levels
  - Put Information where the operator IS, while viewing the plant in person
    - Observe the relationships of the operating equipment
    - Key into our smartphones
    - Get away from the sedentary lifestyle

Not All Technology is Expensive

What can I do for $5,000-$10,000?

- Send Custom Reports to my email address
  - For the vast majority of systems, using non-customized technology
- Install 4 thermocouples on my Economizer and monitor Energy Saved

What can I do for $3000-$6000?

- Repeat my operator screens to a web Browser
  - For most systems, using Off-the-shelf software
- Install 5 Video Cameras

Not All Technology is Expensive

What can I do for next to nothing?

- Put Static information on the PCs
  - Company directives
  - Equipment Manuals
- Move Semi-Dynamic Info onto PCs
  - work orders, Shift instructions
- Give Windows training to your operators

Not All Technology is Expensive

What can I do in my next project?

- Change the structure of your system
  - Use a Web Browser style
  - Put it on handheld devices

Summary

Common Technology

- Changes in Fuels and Boiler Design
- Changes in Instrumentation and Control
- Changes in Communications

has driven many advances in

- SAFETY, Efficiency, Cost Reduction
- Manpower

Summary

From Now on we will see

- Use of the next generation tools
  - Lower cost technologies like Wireless, Video Cameras, web browsers, smartphones
- Implement Optimizing based on more Data
- More technology literate operators

Our Challenges are to

- Implement Technology concepts in our plant ratings
- Put it into our ongoing curriculum