The Changing Role of the Process Operator and Automation's Place in that Future.

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Abstract: There is a revolution underway in the instrumentation, systems, and automation world - digitalization. With this comes the integration of the plant floor and the shop floor. How will this integration of information from field sensor with the current commodity price from the trading floor affect the way everyone operates the facilities of the future? Without going into technical details, this presentation will share some of these trends and how the new Digital Control System will change the role of tomorrow's panel operator from one of process player to that of process coach.

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1. Control Systems

To start, let's review a bit of history. The original 'control systems' were in fact local pneumatic control loops, often consisting of a single valve or analog output and a single analog input, typically a thermocouple, pressure or flow signal. Of course, the next logical step was to bring this information to a central location so an overview of the entire process could be captured and optimized by a process operator.

The next move in this evolution was the introduction of analogue voltage or current signals. After about 10 years of debate, ISA 50 agreed on the now ubiquitous 4 – 20 mA standard. The distributed control system was born in the 1970's. This centrally located, but distributed computing environment[1] continues to be the mainstay today, but the tide

[1] Many computers operating in parallel.

is changing again. Fieldbus networks have been evolving for the past 10 years and are fast becoming the preferred platform for today’s control systems.

How does a fieldbus network differ from the traditional analogue, pneumatic, or electronic control system? Fieldbus systems differ in that they are ‘all digital’ from the sensor in the field right through to the operator interface and above. This means that the field devices are now part of the computer so all the information stored in the device is accessible to every other device connected to it. Also, as the name implies, fieldbus systems are targeted and applied to the field level of a plant. This also means that not only must the system be robust, it also transmits less data than for example an office LAN. All fieldbus network data traffic consists of small data packets that can be sent quickly even at low speeds. An analogy is that of a tree, the field devices are the roots, the control system host and operator stations are the trunk/branches, and the individual PC’s on the corporate LAN as the smaller branches and leaves.

Many of you are at least familiar with the ‘fieldbus wars’ and may wonder what it was all about, other than market share. What differentiates the different fieldbuses, at least those that share a common infrastructure is the User Layer, which is where the bits and bytes become words and numbers. User Layers can be thought of as languages, and unfortunately, each network is unilingual. As with most languages, even if the words aren’t the same, the information or object still exists. Therefore, regardless of the bus selected, a wide variety of information is available from every device. Typically this includes things in addition to the process variable like:

Digital Process Variables — Multiple variables from one process penetration in engineering units.

Status — Device malfunction, Out of Limits process variable, and fixed or saturated signal alarms.

Device Information — Tag number and name of instrument loop, manufacturer name and device type, revision number of the software/firmware used in the device, and the device serial number.

Diagnostics — records of configuration changes are stored in the device. It is also possible to do a loop test by forcing a signal to the device.

Calibration Data — Engineering units used for all information, upper and lower range values, upper and lower sensor limits, minimum sensor span, signal damping in the device, and date of last calibration with associated notes/changes are all stored in the device memory.

Diffferent buses provide different levels of the above information. In many cases, especially for the protocols applied to the continuous process industries more information than is listed above is available.

This large amount of data, in some protocols, is used at the device level as well as higher levels in the network. To be truly useful, this information needs to be communicated “up” to other computer systems and eventually to a Human interface and/or other computer programs so it can become information.

Turning back to our tree analogy, as the information flows up and concentrates, the need also arises for more bandwidth. The same is true for a control system. Control systems however are now turning to Ethernet to provide this higher data transfer medium.

Once again, despite most systems now using Ethernet, communications protocols continue to compete. This is because Ethernet, TCP/IP, and UDP only define the physical layer (wires and signal format), Data Layer (how to package the data), and network layers (where to send the data). The Presentation and User layers of which there are many, define what the bits and bytes mean, that is, what language the message was written in. One positive trend however is that many control systems are moving towards use of a web based operator interface or HMI (Human Machine Interface).

This is positive news for a number of reasons:

- Operators are familiar with this interface including hyperlinks and navigation tools
- A large pool of people and tools are available to create these interfaces.[2]
- Commercial Off The Shelf (COTS) hardware can be used to create the network.

Use of this web-based environment extends even further. By providing a way to sent the same panel or HMI information back into the field. Through the use of wireless Ethernet, 803.11, and the same web based HMI; roving plant operators could have access to the same information as those at the panel.

In the control room, use of common hardware and software makes it possible to provide more for the same cost. Typically, this ‘available’ money is used for ergonomic, health and safety reasons, to improve the environment itself and the sharing of information between operating panels. A common information-sharing tool making resurgence is the panel board. In the past, this was a graphic painted on the control room wall with pneumatic signals and gauges ‘peaking’ through at key points in the process. Today, the same thing is accomplished with full or partial wall plasma displays that allow panel operators from adjacent units to get a quick overview of how process conditions elsewhere in the plant are affecting or being affected by the unit they are controlling.

Obviously, the process operators do not need to use all the information identified earlier and now available to them from this digital network. Based on the type of information

[2] With the proper management of change procedures in place, it is possible for the operators themselves to design the look and feel of their consoles or at least create as a minimum custom data screens for key parameters they use to watch the process.

identified above the next logical groups to find benefits from digital instrumentation are the maintenance technicians and control engineers. Yet, the process operators will also find value from more than the traditional process variable only information. How often is it that operators question the validity of a process value because it does not agree with their ‘gut instinct?’ Digital control systems allow them to poll the device for its operational status and confirm whether or not it is operating properly. This in itself could justify installation of a digital network.

Unfortunately, at present not all control systems can access any of the additional data beyond the process variable without installation of extra hardware and software. This of course means more complexity and possibly lower overall system reliability. The good news is that most manufacturers are moving to tighter integration of both their hardware and software environments and basing these environments on global standards.

2. “Economics”

Without going into great detail about all, the necessary ‘boxes’ it can be seen that in some cases there is added complexity associated with the ‘extra’ information associated with digital devices however the economic return is significant. For example, in addition to the example given above consider:

- INTEGRITY IMPROVED**-** Improved Diagnostics = Improved Integrity- Condition Based Maintenance Systems can prove plant condition- Future Concepts come into play (Self Validating Instrumentation). Value, saving of 20% on Integrity Report production with more accurate results.[i]

- ADVANCE PROCESS CONTROL Implications – Self Validating Instrumentation = validated data = conservative value of 0.1% additional total production

- INSTRUMENT PERFORMANCE - No need to undertake planned maintenance, as the Instrument will flag problems and that Instrument Performance is dropping. A minimum 30% maintenance savings.

- REDUCED COMMISSIONING AND STARTUP COST**-** Potential Huge Saving. With competent people loops commissioned in 15-30 minutes (against 6-8hrs). Base savings on the number of loops X 5.75 hrs X $Rate

- EARLY STARTUP - consider that instrumentation is typically at the “tail end” of the project and the cost benefits of an early startup.

- REDUCED ENGINEERING AND CAPITAL COSTS- advanced electronic tools afford “slick configuration”- Savings could be up to 40% of design costs after initial comprehensive training

- INSTALLATION, TERMINATION AND WIRING - Usually Identified as a 20% saving- Not a huge amount (normally around 5-7% of project cost)

- DEVICE “PLUG AND PLAY”**-** Instant Device ID when connected-with all features savings when new instrument is added to the network = 1hr@ technician rate X the number of Instruments.

Obviously, with this much value waiting to be captured, it is only a matter of time before digital control systems replace today’s analogue units. In fact, an article by Dave Woll of ARC Advisory Group in his article[ii] “Process Automation at a Crossroads” indicates that this research group estimates $65 billion US worth of legacy systems will have to be upgraded.

One final note related to the economics of digital control systems and the associated integration and that is “Metcalfe’s Law”

> *“The value of a network is proportional to the square of the number of nodes, so as a network grows, the value of being connected to it grows exponentially, while the cost per user remains the same or even reduces.”*

What other changes are happening to today’s control system that will affect the people working with this technology and the increase in information now available?

3. Alarm Management

Alarm Management is another significant issue facing today’s operators and it could potentially become even larger as all the possible ‘extra’ alarms such as device status can be annunciated to the panel. A number of different approaches are being taken to this problem, ranging from “home grown’ through company specific, academic, and industry sponsored consortia. In all cases, the intent is to prevent an ‘alarm storm.’ ‘Alarm storms’ occur when the tripping of one alarm, for example loss of a pump, results in a complete suite of associated alarms, such as loss of discharge pressure, high level in the upstream vessel, low power to motor, etc. Any process operator who has enough experience to be operating the panel will already know this so the extra alarms become unnecessary. It is the responsibility of the alarm management system to automatically inhibit all the associated and now ‘redundant’ alarms.

Two industry consortia the author is aware that are working on this issue include one, being led by Honeywell – the Abnormal Situation Management group and another based at Oxford University’s University Technology Centre for Advanced Instrumentation[iii] sponsored by Invensys. Results of the work from these groups are being implemented in new products from consortia members and include such things as:

- Graphics used on the operator displays
- Graphic colours
- Diagnostic and event history capture tools

However to take advantage of this new technology requires work. Up front the work involves a multi-discipline team to identify the process interactions, similar to the example that can be combined into a common alarm. Then after this is done, the appropriate code needs to be entered in the control system. Then last, but not least is the discipline to maintain the system and apply the same thought process to any new alarms or equipment being proposed or added to the plant.

The following quote from Honeywell's ASM page indicates just one more reason why alarm management will become more common; "From a return-on-investment viewpoint, ASM Consortium research indicates that, on average, incidents result in the loss of 3 percent to 8 percent of a process plant's capacity each year. We estimate 5 percent to 12 percent of that is due to alarm management problems."

4. Enterprise Integration

As mentioned in the discussion on changes to the control system environment, Ethernet and web based interfaces are becoming more prevalent and since this is the same environment used on most desktops, the integration of the control system and business system now becomes not only easier, but also more complete.

Today's business trend of manufacturing high quality product, on time and in some cases as individually customized requires that information for each customer order may need to be sent to the control system and responded to by the process operator. Other 'drivers' for tighter integration include being able to respond to commodity prices as they fluctuate, especially in a multi-product chemical plant where the ratio of iso to normal diomers or different grades of gasoline change regularly.

One of the software tools being used to transfer this data between applications across platforms in Object Linking and Embedding (OLE).[3] Because control systems have some additional requirements beyond a corporate LAN, OPC (OLE for Process Control) has been developed. OPC comes in two 'flavours,' DX and DA. DA or Data Acquisition is used to communicate between a client and server or publisher and subscriber meaning that one machine requests information from another who then publishes for others to read. DX (Data Exchange) allows for server-to-server communications without an assigned 'arbitrator' thus making it possible for two devices with different protocols to share information. This has important implications, as it will make it possible for direct transfer of data between different control systems.

[3] OLE is used to embed a spreadsheet into a Word document or PowerPoint slide that is automatically updated when the original slide gets updated. It is based on the COM and DCOM technology supported by the Microsoft Operating System. Recently, Linux has also developed a way to support this technology as well.

One thing that will be important with integration of the various platforms is again that of security. It will be critical that the process control system is isolated from the Corporate LAN environment and direct connection to the internet as introduction of a virus on a control system could have dire consequences. This to will rely on discipline of the operators. Many of today's control systems do use Microsoft operating systems, and hence are susceptible to the same viruses we get at home. These systems also in some cases use portions the same software to monitor and analyze the process as the corporate desktop so the temptation to quickly use the same machine to type a memo to/from floppy disk must be avoided.

5. Real time Optimization

Other forms of real time optimization will become more prevalent in the future. Today's control algorithms typically optimize across a single unit operation such as a distillation column or reaction vessel. The next level of integration will be across an entire operating unit consisting of multiple vessels, and then soon after across units to cover the entire plant. The author is aware of a control system that has the potential to integrate across multiple plants that via secure internet or Wide Area Network (WAN) could even be extended across several plants to form an integrated multi-unit operation.

It is also becoming more common to see multivariate tools being used off-line to identify relationships between what had previously been thought to be unrelated variables. Platform integration, increasing computing power, and advances in these algorithms will soon make it possible for the control system to make 'suggestions' to the operator on how to improve the process operation to capture fractional percentages improvements in yield in real time. Within 5 to 10 years, this coaching will become so accepted that it will instead be automated and the operator's role will be to use their heuristic understanding of the process to spot anomalies in the process or alternately to mediate between suggestions from these real time optimization applications, of which one could be based on environmental constraints and another on the latest market price for one previous 'waste' stream.

6. Conclusion

As this paper has shown, just like history which repeats itself, the control cycle has completed another round, going from local control and interfaces to the same situation again, only this time with more and richer information. The challenge we face is how to prepare people to maximize use of this information as the cycle continues!

7. References

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[i] FOUNDATION™ fieldbus – The Route to the Future", Jim Russell, PACEX Conference May 30, 2002 – Sydney NSW Australia

[ii] Process Automation at a Crossroads, Dave Woll, Hydrocarbon Processing, Vol. 81, No 4, April 2002 (www.hydrocarbonprocessing.com/archive/archive_02-04/02-04_control.html)

[iii] http://www.eng.ox.ac.uk/World/Research/Summary/B-Invensys.html