What have your machine controls done for you lately?

I'd like to talk today a little bit about control systems and how they are evolving to meet the needs of today's manufacturers. There are a lot of things going on in control systems these days, and many that I could choose to talk to – faster and more powerful processors, for example, or manufacturing network convergences – that is, how networks seem to be converging on Ethernet, or I could talk about wireless control, or Internet connectivity, to name a few. But I thought I'd focus today on 5 key areas, and talk about what they might mean to you and try to give an example or two of how they might be useful.

I want to focus on:

- sustainability – always a hot topic; I'll focus on a very tangible benefit opportunity
- activities around safety – both personnel and equipment safety
- I'll talk about advances in predictive maintenance for your equipment
- Then, something on productivity and operating efficiencies, and
- Finally, machine design efficiencies.

Most of these trends revolve around the gathering and then acting on information that could be available from your control system. While some of the progress is in the components that affect machine performance, a great deal of it comes from advances in software – both in how machines are controlled and how information is extracted from them and organized. I hope you see some opportunities here to leverage your control systems to improve your profitability and bottom line.

Sustainability:
Lets start with sustainability. Sustainability goals usually include reducing your carbon footprint, utilizing energy more efficiently, and reducing waste, among other things. This is a huge topic, and one that can occupy us all day. What I'd like to focus on here is the idea of taking advantage of your control system in an innovative fashion to manage your energy utilization more efficiently. You may have heard that manufacturing consumes more electricity than any other sector, and that rotating motors consume about half of all electricity. And, traditionally, this energy has been viewed as a cost, a bill to be paid as overhead and an expense to be controlled.

Some manufacturers however, are viewing energy (in all forms, but I'll focus on electricity) as a tangible component of a product – something that can be measured as an input to production, such as Watts per ton of product, or even captured and added to the bill of material. When you use your control system to track and record energy usage in real time, you open up possibilities of managing it much more precisely - and more profitably. By gathering energy usage with this level of granularity, you can separate production usage from facility consumption, and identify heavy energy consumers in processes, machinery, or specific products. This allows a plant manager to identify variable energy costs on the plant floor, and target areas for improvement. Manufacturers and machine builders can also use this information to influence machine design practices to improve energy management.

Some manufacturers are using this information to improve profitability. By scheduling energy intensive product runs or activities outside of peak demand windows, they are using this information to more effectively manage their cost of goods sold. And finally, the unit-level energy consumption information can become valuable input to sustainability scorecards and other reporting mechanisms.

It's a whole new way of looking at energy consumption and costs, using your machine control system, that can make a difference to your bottom line.

Safety:
Machine safety directives are another area that is getting a lot of attention lately. All manufacturers want to provide a safe workplace for their employees. But at the same time, they understandably are quite concerned about productivity. Happily, in recent years there have been many innovations in control equipment that improve the safety of your personnel – and equipment – while at the same time improving your productivity. In addition to safer control equipment, new ways of looking at machine safety, starting with risk assessments, and looking at machine safety from a more holistic perspective, can actually accommodate improved safety and productivity at the same time.

Lets start with safety controllers. In the past, safety systems required hard wiring and electro-mechanical components, as specified by NFPA79. As controls evolved to PLC's, the safety circuits were accomplished by redundant controllers, additional I/O, and lots of cross-wiring. These worked, but meant a lot of engineering and assembly labor to design and build, and quite a bit of effort to maintain. Recent developments in safety controllers have dramatically reduced this design, build and maintain effort. In general, the safety controllers build the redundancy into the controller, and monitor them continuously. At the same time the functionality of new safety input and output devices are continuously exercised for short cycles, and also incorporate redundancy to reduce the likelihood of failure. More importantly, this allows the system to discover failure as soon as it occurs, before it's a surprise, then it can default to a known state and provide an orderly shutdown. These capabilities are rigorously tested and validated before certification is provided. The result is an extremely robust, but efficient component of your control system.

Probably the area of the control system that has the most cause for concern regarding personnel safety is the drive/motor area – the components that provide the motion in a machine – rolls to turn, actuators to engage, etc. Again, recent strides here have added a level of safety that is unprecedented. In the past, it was always assumed that a machine with no power to it was the safest. And that may still be true, but there are many situations where maintenance or troubleshooting personnel need to turn a roll or open a nip. Many manufacturers now offer drives with safe-off, safe speed, safe torque, and safe direction features. These features ensure that motion can happen, but in a certified safe manner.

So how does this affect productivity? Lets say an operator needs to clean a pair of rolls. Roll nips are one of the most hazardous locations on many converting machines. If the operator needs to jog the rolls to complete the cleaning operation, power cannot be removed from the machine. With a safety controller and drives with a safe speed and safe direction function, the machine can be put into a “cleaning” mode, where speed and direction of the rolls is being controlled and monitored. In addition, a safe torque function could recognize if something got caught in the rolls and required additional torque to continue, and shut down the system immediately.
In another scenario, say a spill needs to be cleaned up on an indexing table. A safe off function disables the output of the drive, guaranteeing no motion, while maintaining power to the drive so it “remembers” its position, and no homing is required, thus production can restart rapidly from the current position.
Another example of a holistic approach that can improve productivity and operator safety is zone control. Say an operator needs to replenish pallets in the hazardous zone of a robot palletizer. Placing the system in “pallet load mode” establishes a safe zone of travel for the robot, allowing it to continue to operate in that zone, but preventing travel outside the restricted zone, where the operator could be injured.

These are several examples of how recent advances in control system safety can dramatically improve and simplify machine design, reduce risk to personnel and at the same time improve machine or line productivity.

Next let’s turn to ways that control systems are evolving to provide more information that can be used to help you run your business more efficiently. Not that the previous ones don’t, but these do in different ways.

Predictive maintenance:
Those of you that attended the AIMCAL Winter Management meeting may remember a couple of excellent presentations by Jim Pinto. He spoke about some things that are coming in factory automation. One of the things he mentioned is “predictive maintenance”. What did he mean by that? Well, as control components become more sophisticated, they can monitor themselves, or other parts of the system, even provide some maintenance functions themselves, and let you know about upcoming potential concerns.

Condition monitoring devices can track and report many conditions that are indicators of machine wear or potential problems. Changes in machine characteristics like vibration, temperature, current or power consumption can indicate problems on the horizon. By establishing benchmarks and continually monitoring and tracking these early indicators, problems can be identified before they become crises. This allows them to be planned for and managed in an orderly manner.

In addition, some control system components are developing capabilities to help maintenance personnel keep them running well. Lets take variable frequency drives as an example.

One common failure point in drives are the cooling fans. Algorithms can be developed to predict their lifetimes based on measurable conditions in the drive – like run time and temperature. So a parameter can be used to track elapsed life and remaining estimated lifespan. This parameter could then be alarmed in various ways, and passed to the controlling PLC to be articulated to the maintenance staff. This allows planning for and replacing the fan under scheduled conditions close to when it's predicted life is over. Similarly, drives can be set up to track motor bearing wear, or lubrication life expectancy and report when scheduled maintenance would make sense.
Another important component to watch in drives is the DC Bus capacitors, another common failure point. Their lifespan is greatly influenced by temperature and output current and ripple. These can all be monitored. So again, replacement here can be planned for and managed in a nondisruptive manner.
Another item that can be monitored in a drive are the output relays. The life of their contacts is a function of load type, current loading and number of cycles. These parameters can be tracked and the relays lifespan predicted, reporting how many cycles are left before the expected demise of the relay, so they could be replaced before failure.
Finally, since drive temperature has such an impact on so many components, some manufacturers are incorporating thermal managers into the drive firmware. When the thermal manager senses an approach to a danger point, it can modify the drive output to reduce temperature loading, greatly extending the life of components.

Software:
Another major trend that is very interesting is the development of software that extends and helps organize the mountain of data that can be extracted from your control systems. As control systems become more sophisticated, the amount of data that is available can become overwhelming. And most manufacturers do not have the luxury of owning machines with identical or even compatible control systems. So they must turn to software programs that can collect information from various sources. For that information to be useful, you need to be able to organize it and place it in context. Controls vendors are developing excellent software programs to do just that.

We can use OEE (overall equipment efficiency) as an example. OEE is a pretty simple and well known measure of machine productivity. It is commonly defined as Machine availability (uptime) x performance (speed) x quality or yield. So if you know the machine speed, quality yield and uptime vs downtime, you can calculate OEE. All this information is easily available from the PLC, given the right sensors, and inputs, etc. Gathering the information is step one, but what can you do with it? The key is learning from it. Why is a machine down? Can you compare across shifts? Or across machine lines? What is the trend? Is it improving or declining? If you can gather the information from throughout your operation and compare it, then it becomes useful in driving improvement.
Some manufacturers are using OEE as a motivational tool – providing real time feedback to operators about how well they are doing, and fostering healthy competition between shifts or machine lines, for example. And it's getting easier to view, as well. New

software packages can deliver the graphical information as web pages - that means that wherever you have Internet Explorer and security allows, you can see the information – in your office, at home, on your cell phone, etc. In many cases, client packages are no longer necessary, just your desktop internet and appropriate security are all that's necessary.
OEE measurements can be very useful in setting goals and improving productivity, but again, the data should be real time, and must be organized and put into context. And it is the recent developments in software that are enabling manufacturers to really take advantage of the data that their machinery is now able to generate.

Machine Design:
The final item I want to talk about has to do with software, and relates back to a point I made earlier about how turning motors is such an energy consumer. Most controls vendors provide software to help machine designers size and select drives and motors to move product through a machine. These programs historically were used to help design the control system. That software is evolving at a tremendous pace and now provides much more capability and really can help optimize machine design. You may have heard it described as Mechatronics, and its usefulness is increasing as it is fast evolving into true digital modeling and simulation. The key point is that it can be used to bring together the mechanical designers and the electrical designers in a way that hasn't been done before to help see the impact selections in one discipline have on the other. Traditionally, mechanical engineers sit in one area and design the rolls and transmission mechanisms, then turn it over to the controls engineers, who size the drives and motors to provide the forces required, and then put a control architecture on top. Mechatronics provides the tools to allow the two disciplines to work much closer together to optimize the machine design. And newer versions allow them to dynamically simulate the design to see how their selections impact each other. This provides the opportunity to test what-if scenarios and make changes based on simulations done at their desk before any parts are purchased. It is a lot easier, and less costly, to make changes at this step, rather than after the mechanical transmission is selected, or when the machine is in factory test or start-up.

These developments promise to make a huge difference in optimizing machine design, reducing cost and improving energy efficiency, as well as shortening the time it takes a machine builder to bring a new design to market.

To summarize, what I wanted to give you today was some insight into some of the exciting developments that are going on in factory automation. Everything I talked about is available now. I wanted to follow up on Jim Pinto's talk last March about the future of automation with some concrete examples of things going on right now. What I really wanted to do is whet your appetite to begin to think of the control systems out on your factory floor as potential partners in making your business leaner, meaner and more profitable.

Thank you.