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7 key points in applying servo drives, motion controllers and PLCs

Technology advances in servo drives have made them the workhorses of motion control. Here are some recommendations for implementing servo drives.

1. DON’T FEAR SERVOS
There are many different levels of positioning and motor controls now. Some basic variable frequency drives can even be used to do what could have been done only with coordinated drive systems in the past. So don’t be wary of servo technology. They are now more cost competitive with auto-tuning, which makes them straightforward to implement.

2. QUICK CHANGETOVERS
Machine setup and changeovers lead to lost production time and inefficient production. Changeovers can vary from minutes to hours. Consider using low-voltage servo drives with built-in encoder, controller or removable memory units, specifically designed for auto-format settings and quick changeovers. Using a customer-friendly servo drive for quick changeovers and machine setup is an investment that can quickly pay for itself, especially for users who run multiple format sizes on the same production line.

3. WHY USE MOTION CONTROLLERS?
Everyone knows some PLCs can do lots of things, and that includes motion control. However, separate motion controllers persist because they perform combined servo and stepper motion control and are properly coordinated as a high-performance system with the same servo drive supplier. Companies that produce motion controllers design them specifically to increase a machine’s output with improved accuracy. Trying to use a PLC to address registration or robot-type control, plus handle recipe data, may require additional PLC programming capability and time vs. some motion controllers. Past experience on such applications says it’s best to use the optimal tool for the job. And with the latest motion/machine controllers with built-in IEC 61131-3 functionality or other straightforward programming capability, you can have the best of both worlds.

4. OVER-SIZING WASTES ENERGY, COST AND PANEL SPACE
Some of the biggest energy wasters on a machine are frequently overlooked. Over-sized servo drive/motor systems, for example, cause machines to consume more energy than necessary—something that can easily be avoided through proper design. End users often underestimate the returns from energy-efficiency investments, since it costs more up front and may take a few years to achieve payback. As a result, they often inadvertently build in extra long-term, ongoing costs by overlooking details when sizing machine components.

When sizing a machine, the entire motion profile is important, not just speed.
Load-to-motor inertia ratios improve response time

Calculating an inertia ratio is often overlooked by newcomers to servo sizing, but is arguably the most important factor in determining the performance of a servo system. Inertia ratio is calculated by dividing the load inertia by the motor inertia. Lower load-to-motor ratios improve response times, reduce mechanical resonance and minimize power dissipation.

An inertia mismatch of greater than 10:1 can produce oscillations and extended settling times. To prevent overshooting and oscillations with very large mismatches, the control gain may have to be reduced. A motion system with a load-to-motor inertia less than 10:1 can reach a set speed or move into position in less time than one with a ratio greater than 10:1. Large inertia mismatches require higher current to drive the motor, thus they dissipate more power. For example, a mismatch of only 5:1 will dissipate six times more power, and it gets worse as the load inertia increases.
and load. Having a detailed and accurate profile of needed motion can pay dividends. Typically, a less precise profile will lead to an over-sized servomotor. This means that the energy consumption of the system will be higher than needed. The key to getting the motion profile right is properly calculating velocity, continuous vs. peak torques, acceleration, and matching load and motor inertias. Further, refine the profile by accounting for cycle times. How long does the system have to move from one point to the next, and how long can it take to complete the entire trajectory?

5. DOCUMENT REQUIREMENTS
When building dedicated automation with motion control, whether you source it out or not, it is extremely important to understand the system you are building and the functionality that you intend it to have. There are different levels of motion control, especially if using a PLC as the primary logic controller. For example, on an indexing assembly station that used a servo drive to index large assembly pallets from one station to the next, the controls company used an incremental encoding servo drive system rather than an absolute encoding system. This error crept in because the original rationale for using an absolute system was not documented. Consequently, in an emergency stop situation, the indexing system would stop and then want to do a complete index, starting from its current point. Had absolute encoding been used as originally planned, recovery from an e-stop would have been very simple. If the expected functionality had been properly documented, additional complexity would not have been added to what should have been a simple solution.

6. MINIMIZE VIBRATIONS
The latest vibration suppression algorithms in some servo drives can actually minimize vibrations from occurring on overhung loads and in the machine base without additional sensors. These vibration suppression algorithms, combined with auto-tuning and filtering, can allow for high-performance motion without complicated mechanical damping or heavy bracing.

7. REDUCE WIRING, SPACE
By using common DC and/or multi-axis servo drives, OEMs can reduce wiring, energy consumption and panel space. These systems use regenerative energy to power other axes, rather than wasting this energy as heat in the electrical enclosure. Panel space is reduced by up to 30 percent, while wiring is reduced by up to 50 percent, compared to a traditional single-axis servo system architecture.
10 tips for switching to predictive maintenance

The primary goal in manufacturing is to keep the line running and building salable product. Maintenance has evolved to fulfill that mandate. It started with reactive maintenance—equipment failed and was replaced. Next, the industry shifted to preventative maintenance, which involves performing service and replacing equipment on a schedule designed to preempt failures. Today, courtesy of intelligent, networked components, forward-looking organizations are transitioning to predictive maintenance.

In predictive maintenance, condition monitoring makes it possible to identify equipment issues before they escalate to full-blown problems. Tracking energy consumption of an ordinary motor can turn it into a complex sensor. Abrupt changes or slow increases can indicate a failing winding or worn bearing before it becomes critical. In a pumping application, it could indicate clogged filters or dry running, before an unexpected filter-cleaning shutdown is required or before air cavitation damage occurs.

Frequent routine device checks in the field are no longer necessary. Most of the things a technician can do with a hand-held device while standing at the device can now be handled from the control room or maintenance shop. Checking a device that appears to be malfunctioning can also be done without a visit to the field.

With a few work process changes and a focus on information from intelligent measurement devices, companies can transition from preventive maintenance to conducting a daily predictive routine, dramatically improving plant operations and reducing maintenance costs. Here are some tips for success in making the transition:

1. MAKE THE CASE
Begin keeping a log of unplanned downtime, including details on duration and estimated cost. This will help you make a convincing ROI argument. Review your existing equipment. You may already have functionalities such as networked components, data loggers, and analytics software.

2. FIND A CHAMPION
Moving from reactive or preventive maintenance regimes to predictive maintenance requires a culture shift. Management support is essential to enacting a maintenance culture that includes work processes that facilitate the change. This change is more than just a maintenance matter.
The industry requires a high level of protection in its processes because of the importance that its information represents. That is why CC-Link IE has the necessary safety certifications implementing corrective measures, control methods and safety curtains to generate confidence and efficiency. CC-Link IE is the future in communication technologies today.
3. CHOOSE THE RIGHT HARDWARE
To be successful, predictive maintenance strategies require intelligent field devices, an open communication protocol, and integrated device and asset management software.

4. BECOME A HISTORY BUFF
Establish a database of performance metrics to delineate the boundaries of “normal” operation. Through subsequent and ongoing performance monitoring and recording, small changes in performance that occur over time can be detected and investigated before there is a downtime event.

5. GO DIGITAL
The 4-20 mA current loop might be the most common sensor output signal, but it does not provide the breadth of information available from digital sensors. A smart digital sensor not only delivers performance data, it can store information like model number and serial number for tracking and identification. Some digital sensors allow users to change parameters remotely, or automatically upload stored parameters at startup.

6. TUNE OUT THE NOISE
Predictive maintenance requires comprehensive instrumentation but the sheer volume of data from thousands of devices can be overwhelming. It’s a particular problem given that a large percentage of readings report steady-state conditions. Use data loggers with triggers to sift out anomalous readings. Look for purpose-built asset-management software and analytic software designed to help prioritize information. Many of these software suites include built-in application libraries and tools to simplify building dashboards.

7. PICK TARGETED TOOLS
Determine the requirements for your particular application. The needs of an oil rig, for example, will be very different from a packaging line for consumer packaged goods. Look for niche solutions designed for the specific use case of interest.

8. CONSIDER WIRELESS
Cutting the cord can simplify installation, cut costs, and reduce maintenance. One North American oil refinery installed wireless temperature and pressure transmitters on pumps for a 90% savings over conventional wired devices.

9. OPEN UP
Several open standards groups have sprung up to support predictive maintenance with smart components. The FDT Group AISBL, for example, promotes the open, vendor-independent Field device tool (FDT standard to simplify the configuration of and access to field devices. Each device uses a vendor-supplied software application known as a device-type manager (DTM), which automatically provide proactive device health alerts. Some DTM’s analyze the data to determine probable cause and corrective action, both for the device in the network.

The Profinbus and Profinet International (PI) organization also supports manufacturing process control and asset management. Their approach is to leverage the diagnostic and alarm schemes built into the instruments themselves. Operating parameters for instruments are set during calibration or commissioning. Readings that fall outside these thresholds can generate an alarm.

10. BE PATIENT
Shifting to a predictive maintenance regime is a process, not an event. Although you can begin collecting data within minutes using some hardware and software tools, it typically takes 3 to 6 months before the system has sufficient history to enable truly effective asset monitoring.
5 guidelines for building a successful data-driven network

The assets in your plant and on the factory floor offer enormous opportunity for insights that can be leveraged to improve operational performance, productivity, and safety. The key is to harvest that data and put it in the hands of decision-makers in an easily-consumable form. To do that, you need a reliable, scalable infrastructure that can provide end-to-end security to protect from the increased threats posed by greater interconnectivity.

The following five steps will help you get the most out of your industrial Internet of Things (IIoT) initiatives:

1. EVALUATE YOUR STARTING POINT
Determine what you have, where it lives, what it does, who owns and manages it and, ultimately, where you want to be.

2. MOVE TO THE ETHER
Migrate and/or update your technology to Ethernet and move away from older legacy fieldbus systems or proprietary technologies.

3. AIM FOR THE BEST
Take a look at your network design and ensure you’re following best practices, such as segmenting into zones and conduits or employing wireless solutions.

4. CHOOSE LAYERS
Protect your network through a layered approach, with security measures built into each level of the network.

5. MAINTAIN OVERSIGHT
Establish ongoing monitoring and troubleshooting to keep up as technology and security threats evolve.

As more devices are connected to the network, there will be more interconnectivity with the enterprise side of the business and more users with access to the network. This increase in users, whether they are internal or external partners, means more sources of potential infections. Therefore, it’s critical to address security issues and put measures in place to protect your industrial network.

Even if you still feel uncertain about IIoT in general, or how technology or security threats might evolve, that doesn’t mean you can’t take steps today to be prepared for the future. A scalable and secure infrastructure is the foundation for enabling you to build whatever network application you might need years down the road.
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7 safety functions that can save you money

There was a time safety meant electromechanical relays that cut power to the equipment anytime an operator hit the e-stop button. Although this was effective, it was hard on equipment and often more extreme than circumstances warranted. Frequent stops cause premature failure in the safety relays. Restarting equipment added delays and extended costly downtime.

Today, the modern crop of safety standards such as EN/IEC 62061 and EN/ISO 13849-1 enable equipment to invoke safe states as defined by the function of the system. This functional safety is implemented by safety-enabled drives and PLCs. Functional safety makes it possible to protect workers and equipment while minimizing the impact of those measures on operating costs and productivity. Here are a few of the key safety functions that you should know about:

1. SAFE TORQUE OFF (STO)
   Removes power to the motor but leaves the drive energized. This puts the equipment in a safe state while making it faster and easier to restart.

2. SAFE STOP 1 (SS1)
   This controlled stop enables equipment to be slowed before STO is invoked. It is an active braking operation that can safely and more effectively stop equipment with high kinetic energy.

3. SAFE OPERATING STOP (SOS)
   Drive holds motor in a static position to within a certain tolerance defined for the drive. Torque to the motor is not removed; the motor is just held to zero speed.

4. SAFE STOP 2 (SS2)
   Controlled braking ramp, once again, suitable for equipment with high kinetic energy. SS2 is typically followed by SOS, rather than STO.

5. SAFE BRAKE CONTROL (SPC)
   Controls an external holding brake in conjunction with safety drive. Typically applied to loads on vertical axes.

6. SAFELY LIMITED SPEED (SLS)
   Sets a maximum speed at which the drive can run the motor. Useful for protecting operators when they are working in close proximity to equipment. It
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enables them to use the power of the motor to assist them in clearing jams without placing them at risk.

**7. SAFE DIRECTION (STI)**
Restricts drive signal so that motion takes place in a single direction. This can enable operations involving workers to take place at higher speeds, for example pulling a gripper away from the operator at full speed because the direction of motion does not present a risk. It can also be used for maintenance operations like cleaning rollers. These can be conducted as clean-and-jog procedures but with SLS and STI, the rollers can be commanded to rotate away from the operator at a low speed to enable continuous cleaning.
10 ways your automation project can fail and how to prevent it

From failure to define requirements to disengaged project managers, changes in direction or employees who lack the skills to do the job, the sources of automation project failures are often easy to identify. Fixing them is usually the bigger challenge.

1. **NOT GETTING MAINTENANCE AND OPERATORS INVOLVED FROM THE START**
Some assembly jobs have been done by hand for years. The worker who has been on the line for a long time will have seen what has and has not been done in the past. Just because components on paper are all uniform does not mean that they are in tolerance in the real world. Maintenance workers have dealt with more fixes and operator complaints than the design engineer. The key to a new piece of equipment working well is maintenance and operators taking ownership of the system. If they aren’t on board, the machine may just end up being a big paperweight.

2. **LACK OF THE RIGHT PEOPLE RESOURCES**
Too often a project is running at full throttle, only to come to a complete stop because the person originally tasked to do the PLC engineering or development is busy putting out fires, has inherited another project or is otherwise not available. When developing schedules and project plans, try to gain stakeholder commitment to use contingent resources or assign another skilled resource based upon a scheduled “check” item.

3. **UNENGAGED PROJECT MANAGERS**
When the project manager is unengaged or unresponsive to requests for information or approvals, you know the project is destined for failure.

4. **LACK OF SCOPE BENCHMARKS**
Without scope benchmarks in place that are tied to the proposal document, the project manager can’t assess programming time for each phase to help detect scope creep. Benchmarks help deter project stakeholders from adding “capabilities” to the process that can lead to both financial and timeline strains, and ultimately to a failed project.

5. **SKILLS MISMATCH**
Many automation projects are viewed as successful when the system is in the development and testing stage, but it becomes an entirely different scenario when the project is implemented in the field. Errors begin to crop up. This is often due to the different skill levels of the people who develop the project compared to the people who are sent out to execute it in the field.
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10 ways your automation project can fail and how to prevent it

6. POOR PLANNING
Most projects fail because of poor planning. There is a tendency to underestimate the complexity of the project and overestimate the capabilities of the team. Late changes are the worst enemies of any project. The project owner also needs to establish the most important priorities for the team, such as cost, quality, maintenance, training, stocking of components, safety, etc. This will assure that decisions are aligned with the project’s goals.

7. FAILURE TO MANAGE EXPECTATIONS
Make sure all stakeholders understand the trade-off between scope, budget and time frame. Communicate this deliberately, formally and frequently.

8. DESIGN MISALIGNMENT
Failure often comes from a lack of communication on the design of the project, from component selection to the format of I/O tags, networks and programming structure. Provide a scope prior to design that allows all items of

5 points for failure

- Failure to plan for and handle project resource changes.
- Failure to know or admit that requirements are not well defined.
- Failure to address requirement definition problems in a timely fashion.
- Failure to plan and execute design review and approval milestones.
- Failure to engineer the verification of project deliverables sufficiently, including lack of inspection and test planning.
the design to be agreed upon. As this document is created, members of the
team or the integrator can then point out potential pitfalls, such as using mul-
tiple networks or not selecting a common controller.

9. CONFUSION
An insufficient amount of effort in the front-loading stage, or subsequent
budget cuts or direction changes by management, will result in confusion for
the project team. It’s a standard recipe for failure.

10. OTHER REASONS FOR FAILURE
• Unrealistic schedules are set.
• Potential risks are not calculated and planned for.
• Engineers working on a project lack the necessary skill sets or experience.
• Insufficient milestones to measure progress and identify problems.
• Outdated/incorrect documentation in brownfield projects.
• Insufficient time in the schedule for third-party communications or for de-
veloping a particular section of the system.
• Mismatch in the requirements of the project and the solution given by
the supplier.
• Missing of the minute details pertaining to engineering and scope of supply.
• Failure to establish a clear schedule to finalize process and equipment designs.
• Lack of training to enable plant personnel to operate and maintain complex
systems and new technologies.
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It all comes down to the details. That’s as true for networking as it is for every other aspect of an automation project. Here are some tips for making sure the details are covered with your industrial network.

1. KEEP A LIST
Networked devices have addresses. It is very important to keep a list that shows the assigned address, the product this address has been assigned to and the line/plant location where the product has been installed. It is very difficult to troubleshoot systems if this basic information has not been captured, leading to significant equipment downtime. Once installed, these devices need to be labeled accordingly since it is not uncommon to have several identical devices in close proximity. This information should also be part of any electrical and mechanical drawing.

2. TEST TO FAILURE
When developing data collection/data passing applications (PLC to PLC, PC to PLC, etc.) using Ethernet, fieldbuses and especially proprietary networks, it is critical to test to the point of failure. These failure points can be associated with the number of Ethernet port connections, the size and frequency of data being managed, as well as data addressing in the PLC. The PLC addresses used in data collection, if not contiguous or near contiguous, can cause excess read/write cycles to the PLC. Some PLCs can only provide X number of devices in one read. If that number is 1k (1024 devices) and you attempt to read the values of coils 250, 1400, 5000 and 6500 in one cycle, it can actually create four separate read requests. This results in performance issues and missing data. Think of the impact if you want to read 250 values! FMEA (Failure Modes and Effect Analysis) is a great tool to aid in trying to identify things that can go wrong.

3. BE AWARE OF SECURITY ISSUES.
You have to be constantly aware of the security aspects of your control network. Seek cooperation with the IT professionals; you likely have more overlap with office systems than you might know.

4. AVOID SUBNETWORKS.
When selecting a fieldbus or network architecture, avoid the use of subnetwork systems or expandability features that require configuration of expansion modules or field devices separately from the PC or PLC. Subnet components add an additional burden for end-user support and complexity in software (re-tagging/programming) when the subnet I/O count or type changes.
CONTINUED  9 ways to build a better plant-floor network

5. BUY A NETWORK ANALYZER
When a system using a fieldbus/industrial network does not work as expected, somehow the network is always blamed: too slow, too many flipped bits due to EMC (electromagnetic compatibility) issues, etc. Without proper measuring equipment, a network troubleshooter won’t stand a chance of disproving this. Make sure high-quality network analyzers are available, and the real root cause of the problems will show up very quickly: very often it is application software. A network engineer without a network analyzer is like an electrician without a multimeter: clueless.

6. NETWORK EVERYTHING
Nothing is not in the network anymore. When you implement a new project or a new system, the networking criteria are a critical consideration. Every device needs a communication port or ports, physical media, communication protocol and tools to configure, display, diagnose, analysis, etc.

7. ROUTE SEPARATELY FOR RELIABILITY
To have a more reliable DCS system in factories, use high-quality network and fieldbus components and make a separate route for network cables. This will help guarantee system performance.

8. MATCH MEDIA TO CONDITIONS
There are a variety of different types of network connectivity. Choose the media according to the environment and conditions under which this network will operate. As an example, you would not use Cat6 wire for an Ethernet communication between buildings. Use fiber instead due to lightning conditions. You could also use wireless modems instead of fiber when the distances between buildings are great.

9. PROTECT SENSORS ON MOBILE EQUIPMENT
When using wireless in a dynamically changing production process where machines or sections of a production line are moved frequently, protect sensors mounted on machines with enclosures that prevent workers from removing them. This solution is also helpful in preventing damage to the sensors when moving equipment.