SPS IPC Drives Italia 2018

The Paradox of Smart Manufacturing

Smart drives and control platforms provide a way for companies to improve manufacturing while lowering price, enabling them to deliver more for less.

Under SPS Italy 2018 topic of "***The challenges of automation: efficiency and flexibility",*** *which* will be held on the second day, Wednesday 23th May.

Consumers today want more— more functionality, better quality, and more layers of customization in the goods that they buy. Schooled by the semiconductor industry, they expect each generation of products to be smaller, faster, longer-lasting, and more reliable than ever before. Above all, they expect those products to be cheaper than previous generations, no matter how great the enhancement. This situation presents manufacturers with a major challenge. How do they deliver on customer expectations for performance and price while still remaining profitable? How do they deliver more for less? It seems like a paradox, a problem with no solution. In reality, the automation industry offers technology that converts this seeming paradox into an issue with a clear solution—smart manufacturing with today's intelligent, efficient, and highly functional servo and motion components.

Smarter manufacturing, better manufacturing

To deliver on customer demands, manufacturers around the globe are transforming their production floors from outdated plants into cutting edge, highly efficient factories. They are applying technologies like intelligent automation, big data, online condition monitoring, and more. These smart technologies are changing the face of manufacturing.

Figure 1: Smart Factories, Smart Machine. Eveything smart, but what's the value of 'smart'?

The shift to smart technology is not only a result of organic industrialization, but more important, a direct outcome of industrial movements and various well-funded governmental initiatives. From Germany's Industry 4.0, to "Made in China 2025" and "Made in India," seemingly every country is trying to carve out a position in the fourth industrial revolution. South Korea's Smart Factory plan, for example, calls for the creation of up to twenty thousand smart factories through the country.

The ultimate goal of these initiatives is to accelerate economic growth by upgrading manufacturing. China, for instance, has laid out a long-term plan composed of nine main

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strategies, of which smart technologies, smart production, and green technologies are of absolute importance.

Manufacturing needs to improve
To deliver on customer demand, industry needs to improve manufacturing in four key areas: flexibility, efficiency, quality, and technology.

Flexibility:
The days of a dedicated line turning out one product 24/7 are long gone. Consumers today expect choice, and their needs and wants change constantly. In response, organizations aim to use the same line to build a mixture of products, often in small quantities. The approach serves customers, but without the economies of scale found in volume, small lots up production costs. To address this issue, manufacturing infrastructure has to become more flexible. Changeovers should to be fast and easy. Equipment should support modifications on the fly. These capabilities allow manufacturers to address customer demand while minimizing the amount of inventory sitting on warehouse shelves.

Quality:
Quality improvement is an essential part of the manufacturing revolution. A machine shouldn't just produce more units, it should produce better, more reliable units. Machines need to perform better, also maximizing yield and field reliability. Improving product quality begins with building higher quality machines. Key strategies include improving components, improving the build, and improving the process.

Efficiency:
Offering customers choice and quality is meaningless if the products cost more than they are willing to pay. For asset owners to offer products at a price that attracts business while still turning a profit, the equipment producing those items needs to operate with highest possible efficiency. Organizations want equipment that runs faster and with less downtime. Machines need to be simple to set up and operate so that more time is spent turning out product than performing maintenance or setting up for the next production cycle. Faster operation likewise decreases time to market so that the items spend less time in the factory and more time in the hands of customers.

Technology:
The advanced products demanded by today's market need manufacturing technology that is just as advanced. From smart phones to robotic vacuums to electric vehicles, reliably producing these assemblies requires an investment in technology for technology. The question is how to apply that technology without once again increasing manufacturing costs.

The technology exists to achieve these goals and add value to manufacturing. Unfortunately, adding value frequently adds to price, when the goal is actually to manufacture better products for less. Thus, in using smart equipment to break the customer paradox, manufacturers find

themselves facing a new paradox: how to improve manufacturing while reducing total cost. Once again, the situation calls for finding a way to get more for less. This is the manufacturing paradox.

Fortunately, the manufacturing paradox, too, can be broken. By strategically applying smart motion technology, manufacturers can improve the performance of their equipment without the need for comprehensive (and expensive) hardware upgrades. The key is to implement changes using smart distributed motion control systems.

Smart motion control can increase machine output in its given state, without significant changes to the machine mechanics or overall design. Smart control can help resolve the manufacturing paradox by providing more throughput, quality, simplicity and more, while at the same time contributing to lower costs through advantages like smaller footprint, reduced power consumption, lower downtime, improved time-to-market, and more (see figure 2).

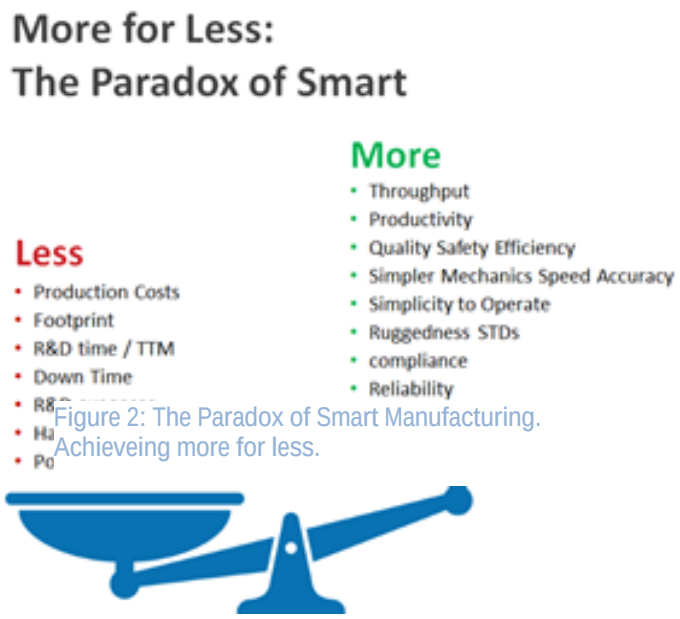

Figure 2: The Paradox of Smart Manufacturing. Achieveing more for less.

Case Study

To illustrate the points above, let's take a look at a case study. A large smart-phone manufacturer based in China wanted to ramp up production in order to meet rising market demand. They began by applying smart control and servo technologies using a three-pronged approach: smart control, lean motion control, and smart safety. By leveraging these smart manufacturing techniques, they were able to achieve the kinds of improvements discussed above but without major changes and large investment.

Getting more from mechanics with smart control

The production line used SCARA robots for tasks such as pick and place, inspection, and mechanical component testing. Convinced that robot capacity had been maxed out on the line, the customer was considering replacing the robots and adding additional equipment. Instead, they decided to keep the existing mechanics and just upgrade them by altering their control and servo drives.

To increase production efficiency and throughput, the existing mechanics of the robot had to be addressed. Multi-dimensional gain-scheduling, position-based plant identification, and other control algorithms were applied to optimize existing mechanics of the robots for different

positions and loads. Automatic changes of the gains and higher-order filters were triggered according to varying position, velocity, and load scenarios. This enabled the robots to reach smooth and stable operation at both high and low velocities, and with different feedback frequencies.

Further drive-level control algorithms were applied to damp vibration excited by high-speed operation. Lastly, additional improvements were achieved by Elmo's multi-axis controller, which increased motion smoothness and reduced motion profile time by introducing multi-axis transitions and blending between moves.

Recall that the customer in this case originally thought they had achieved maximum productivity from their line. That was far from the case. By applying smart drive and control technology, the manufacturer was able to cut SCARA motion profile times and boost machine throughput by 50% (see figure 3), without buying any new robots or machines.

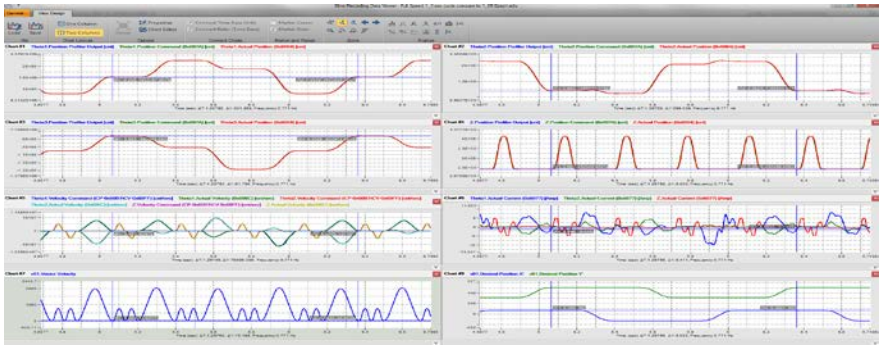

Figure 3: Using smart motion control, SCARA robot motion profile reduced from 1.6 to 1.3 seconds, and made a huge impact on overall throughput.

Saving with lean motion control

On a production floor, real estate is a valuable resource. To shrink footprint, the engineering team swapped out their original servo drives for a 4-in-1 high efficiency, high power density servo drive solution. The new integrated solution occupied significantly less space than its predecessors while reducing wiring, cable carries, and points of failure (see figure 4).

The drives were also selected for their high-efficiency power conversion operation, of nearly 99%. This change not only reduced power consumption but also did away with the need for active temperature control by fan or cooling system, since the drives do not heat up significantly. The result was a significant drop in power consumption, as well as reductions in size, complexity, installation time, audible noise, and points of failure.

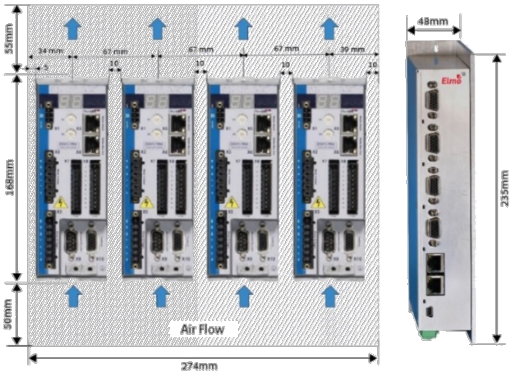

Figure 4: The 4-in-1 servo drive solution (right), compared to the previously used solution.

This customer achieved additional savings in a different application by using Nano smart drives in a distributed-control architecture. This approach enables the drives to be mounted deep within the machine, next to the motors, rather than placed in a central electrical cabinet. The distributed architecture eliminates the cost and space required for the cabinet and further reduces wiring.

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Accomplishing more with smart safety

For many years, safety systems consisted of discrete sensors, physical barriers, and banks of relays designed to cut power any time a designated set of conditions was violated. These types of systems were generally effective but they were also bulky, expensive, and prone to failure. Functional safety provides a powerful alternative that not only protects operators but also improves productivity.

Functional safety, which relies on the servo drive for critical safety functions, holds the potential for machinery to become more efficient, flexible, lean, and autonomous. The technology enables OEMs to simplify machine design by replacing safety hardware with motion-control software (see figure 5). Safety-rated drives monitor current, speed, and position feedback to analyze motion functionality. They typically feature built-in redundancy to prevent common-mode failure.

Safety-rated drives feature built-in safety functions such as Safe Torque Off (STO). In STO, the drive removes power from the motor while remaining energized. This enables the system to restart more rapidly after shutdown due to a fault, boosting uptime and overall equipment effectiveness (OEE).

Figure 5: Functional Safety software. Advanced safety helps manufacturers build leaner, more compact machines

Other sample safety functions available in today's smart drives, although not used in this application, include Safely Limited Speed (SLS) and Safe Direction (SDI). SLS allows the user to set a maximum speed for an axis, while SDI restricts the direction of motion. SLS and SDI can be used to speed manufacturing steps and maintenance. A pair of rollers turning toward each other during cleaning, for example, could potentially trap and injure an operator's fingers. With conventional safety, wiping down the rollers at the end of a shift would require that the power to the rollers be shut off any time the operator enters the enclosure. Cleaning would become a time-consuming clean-and-jog process. By invoking SLS and SDI, the drive could restrict the motion of the rollers during cleaning to only rotate away from each other. As a result, cleaning could take place continuously and at high speed without risk to the operator.

In the case study above, the 4-in-1 solution was also unique in its ability to relay all safety information via the EtherCAT fieldbus (FSoE). Since all drives are enclosed in one package, the only connections each drive has are with the motor and feedback. With this type of safety architecture, machines become highly simplified, reducing cost, components, cabling, and

overall complexity. The manufacturer was not only able to increase throughput but was also able to condense the overall machine design in the process.

Conclusion

Improving the performance of a manufacturing line doesn't always require a full hardware upgrade. A smart servo drive can break the paradox of smart manufacturing and provide both motion- and safety-related improvements for lower overall cost of ownership. These motion control systems deliver more for less, reducing the apparent customer and manufacturing paradoxes to simple problems that have straightforward solutions—smart controls and drives.

Find out what the new generation of smart distributed motion-control products can do for your next application. Contact Elmo Motion Control.

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