Four Demands That Industry 4.0 Places On CNC Machine Controllers

WHITE PAPER

KINGSTAR

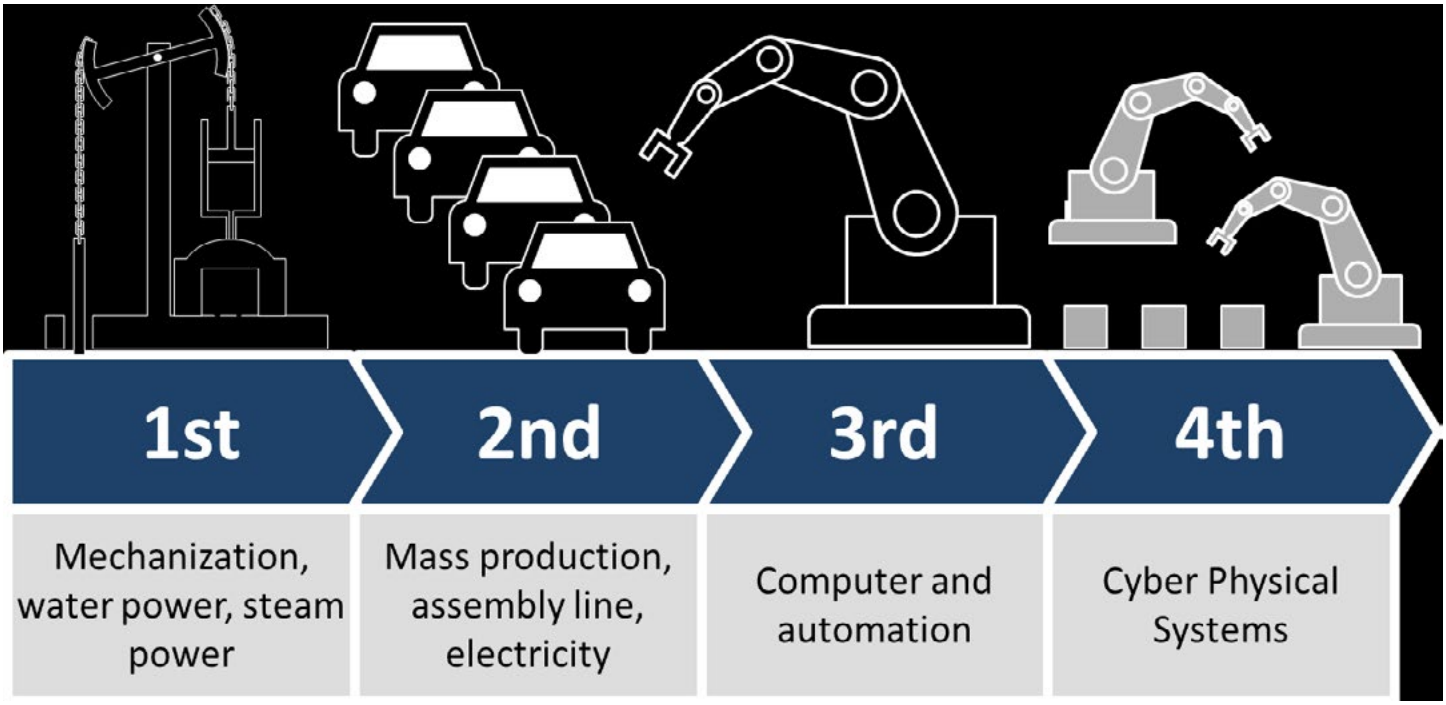
Executive Summary

Industry 4.0 is reshaping manufacturing in the same way that Amazon transformed retailing. The initiative seeks to drive manufacturers and machine builders to integrate all machine automation and machine controller information. By doing so, machine builders can discover new information-based products and identify opportunities to build smarter factories capable of automatically taking corrective or optimizing actions.

CNC is at the epicenter of Industry 4.0. The German government sought a way to protect its auto industry by providing direction and incentives to extend its production capability with advanced manufacturing techniques that leverage information available in the digital era. Islands of automation needed to be stitched together to create a plant-wide fabric of flexible manufacturing. The obvious first point of integration was robot load/unload operations of CNC machines and the simulation for cutting parts. Industry 4.0 has broadened dramatically from its start.

To capitalize on the Industry 4.0 trend, CNC machine builders must ensure that their controllers are capable of supporting four feature sets which enable the integration of different levels of the manufacturing environment, from sensors to cloud servers. But perhaps an even bigger challenge for CNC machine builders is the transition from traditional hardware-based controller architectures to a smart machine automation software architecture capable of executing on any industrial PC (IPC). Only a software-based machine automation approach can deliver the integration and flexibility demanded by Industry 4.0.

Recently, Newfangled Solutions, author of the famous Mach 4 CNC software package, supported an effort to add the key Industry 4.0 features. The solution is already being deployed with remarkable results and can be downloaded for evaluation at ECATCNC.com.



The Importance of Industry 4.0

Amazon transformed retailing and Google came to dominate advertising by applying a tightly integrated digital strategy to a traditional industry. The Industry 4.0 concept seeks to disrupt manufacturing by implementing similar digital strategies as Amazon and Google in the manufacturing setting. Machine builders and manufacturers that embrace Industry 4.0 techniques and implement them in their factories stand to dominate their respective vertical markets, while those that don't will be rendered uncompetitive.

Initiated by the German government, the Industry 4.0 movement is focused on creating smart manufacturing facilities by digitalizing the value chains. This will have a profound and long-term impact on manufacturing businesses worldwide. In fact, most recognize that the 4th revolution in manufacturing has already begun. This is the classic diagram that documents the Industry 4.0 context.

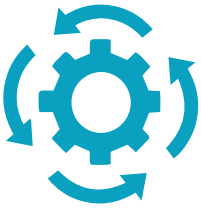
Industry 4.0 creates new product opportunities for machine builder companies in multiple ways:

TRANSFORMING THEIR PRODUCTS INTO SOFTWARE-AS-A-SERVICE

OFFERING UNPRECEDENTED CUSTOMIZABILITY AND VALUE FOR THEIR CUSTOMERS

CREATING NEW REVENUE STREAMS

GAINING NEW INSIGHTS TO STREAMLINE THEIR BUSINESS PRACTICES



IMPROVING OVERALL EFFICIENCY

Alongside cloud computing, smart machine controllers and intelligent edge devices are the cornerstones to building smart factories. Today, according to Forbes research, while only one third of manufacturers describe the degree of digitalization in their value chain as high, more than 80% expect to have digitized their value chain within five years.

Moreover, between 2017 and 2023, the consulting firm PwC projects that the manufacturing and engineering industries will invest roughly $31 billion per year in Internet of Things (IoT) and Industrial Internet of Things technologies (IIoT). Notably, the global IoT/IIoT market is expected to grow from $157B in 2016 to $457B by 2020.

Frequently overlooked in Industry 4.0 forecasts, however, is the role that the smart machine controller will play. The focus tends to be on cloud computing technology that executes predictive analytics and artificial intelligence (AI) to identify actionable insights that can be fed back to the machine controller. But there is more to the Industry 4.0 architecture than just connecting to the cloud. Gartner Group predicts that while in 2018 only 10 percent of enterprise-generated data in an IoT/Industry 4.0 deployment is processed by the machine-controller edge device, by 2025 that figure will reach 75 percent.

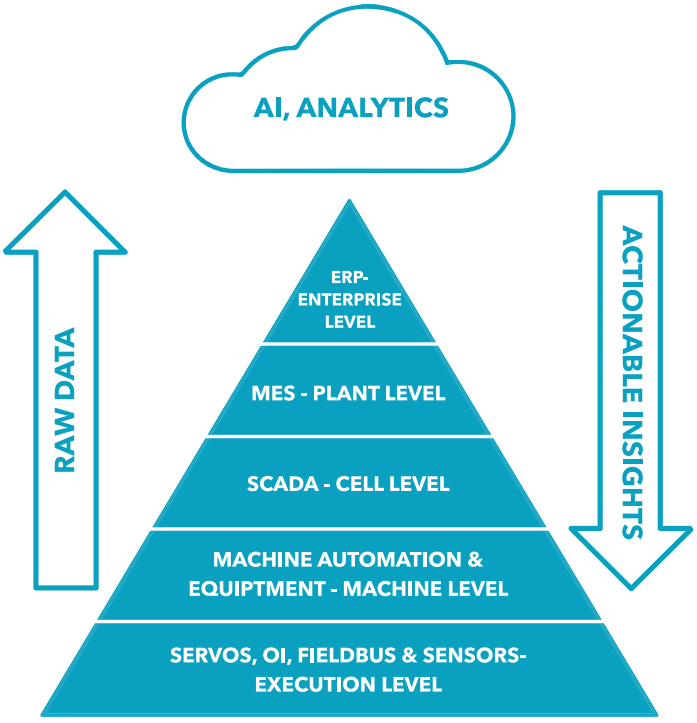
The Role of a Smart Machine Controller in Industry 4.0 Architecture

The main goal of Industry 4.0 is to collect and share all automation information generated by every manufacturing component and machine so, collectively, the manufacturing ecosystem or factory performs optimally. Real success is achieved by analyzing this information to discover actionable insights that come in the form of corrective action or operational streamlining, which can be continuously implemented in a smart factory setting to become more competitive. This is no small task because data must be aggregated, analyzed and re-distributed to all the levels of processing between the sensor and the server.

To meet this objective, Industry 4.0 seeks to integrate and digitize the following six levels of execution and information processing within a corporate manufacturing and supply chain setting:

1. **CLOUD** (artificial intelligence generates actionable insights and product opportunities)
2. **ENTERPRISE LEVEL** (ERP servers)
3. **PLANT LEVEL** (manufacturing execution systems or MES)
4. **CELL LEVEL** (SCADA)
5. **MACHINE LEVEL** (machine automation, machine controller)
6. **ENDPOINT LEVEL** (sensors, motors, drives, IO)

The resulting ecosystem of roundtrip communication for Industry 4.0 is characterized by the following diagram:



The success of an Industry 4.0 deployment depends on a seamless, secure connection and integration with all enterprise information as depicted above. The most success will come when the data is first collected, consolidated and aggregated from the sensors at the machine level and then passed up via SCADA to MES, then to the ERP, and ultimately to the cloud where artificial intelligence can be applied. But that is not all.

With all the focus of Industry 4.0 on generating actionable insights via cloud connectivity and artificial intelligence, there is one very important notion that is often overlooked:

Actionable insights are useless if they are not acted upon.

If the factories and the machines are not "smart" enough to incorporate and act on the insights quickly enough, then the full potential of Industry 4.0 will never be achieved.

Further, as demonstrated by the previous Gartner citation, the often-overlooked but equally-important component of Industry 4.0 is a "smart" machine controller. The machine controller is just as critical and possibly more critical than the cloud functionality. It is the source of the real architectural breakthrough where information collection, aggregation and secure delivery to the cloud begins and ends – in short, where the actionable insights get implemented.

Gartner also believes that endpoint analysis will become extremely sophisticated and predictive over time to improve system-wide responsiveness. If the machine controller is not "smart" enough to adapt to changing manufacturing conditions based on actionable insights or insights that the controller can generate itself, then the Industry 4.0 vision will not be achieved.

4 Key Requirements for Industry 4.0, Powered by Smart CNC Machine Automation

A smart machine CNC controller must have a diverse set of features and capabilities to ensure that the machine can play its vital role in a smart factory pyramid. These features fall into four crucial categories:

1. World-Class Machine Automation

The foundation of an Industry 4.0-enabled machine CNC controller must deliver the best possible machine automation performance and determinism available to the manufacturing industry. It must also achieve these results while embracing the most accepted open standards to protect engineering investments, and it should be flexible enough to adapt to changing requirements for the future.

Given its networking demands and digitization focus, Industry 4.0 demands a standard, widely accepted digital field bus. While there are many proprietary digital fieldbus solutions and some high performing, "open" digital fieldbus standards, EtherCAT stands alone as the most widely accepted standard for digital fieldbuses. Quite simply, it is the safest and best choice for an Industry 4.0 implementation.

In terms of performance and determinism, the closest competing fieldbuses to EtherCAT include PROFINET and Sercos III. Both standards deliver the requisite determinism and deliver the highest quality, but they do so at a premium price. The main issue that drive prices higher is that there are only a dozen servo drive manufacturers have embraced either standard whereas hundreds of servo drive manufacturers have embraced EtherCAT. Having more choice drives the standard forward and lowers prices. A standard is proportionally more effective as the percentage of the vendors in the market embrace it. Hands down, EtherCAT has the best adoption in the market when measured by the number of servo drive vendors that support it.

There are other standards that are vital too, like PLCopen IEC 61131 standard for PLC work. Ideally, the machine automation platform supports 3rd party components and the ecosystem can expand. For instance, real-time vision processing directly on the controller reduces machine setup time and increases machine throughput. This requires a robust, time-tested real-time operating system (RTOS) as the underpinning of the machine automation software. The number of third-party vendors that port their solution to a platform attests to its credibility. Third parties would be reluctant to port their solution to a machine automation platform unless they felt it was a trustworthy and revenue-generating effort.

2. System-Wide Machine Controller Integration

Industry 4.0 is also reshaping the architecture of CNC machine control. Previously, each CNC machine builder provided a controller for their own machine and the machines performed tasks as islands of automation. Industry 4.0 not only demands that machines and CNC machine controllers connect to the cloud, but that they also connect to other CNC machines, robots, and cobots and to sensors that monitor the machines and the environment. All this connectivity opens the door for remote monitoring, remote management and even remote deployment. By combining these elements, a new manufacturing paradigm is driving the creation of smarter factories capable of mass customization and more. (Mass customization is effectively a batch of 1 or even the ability to make different products on the same assembly line.)

To illustrate the value of the multi machine controller integrations that are required for Industry 4.0 deployments, here are two examples.

Many companies are already using collaborative robots (co-bots) to load and unload parts to a CNC machine. Co-bots dramatically reduce integration costs so even small manufacturing sites can take advantage, as demonstrated by this article about Lowercase Inc. and Axis Integration. But as the job gets more complex, PLC or software-based state-machines are required to serve as the traffic cop for process flows between multiple robots, part feeders, vision systems, collision avoidance and other operations. The Co-bot scripting can be complex and often needs to be hidden. And upstream to the CNC, there are typically CAD / CAM systems that feed the CNC, and all the load and unload mechanisms need to be adjusted to accommodate different part shapes and sizes.

Even with integration-reducing solutions like co-bots, there are so many machine controllers and moving parts in a machining cell that need to be integrated to achieve the Industry 4.0 vision. CNC machine builders and factory owners must ensure that the CNC machines and controller development platforms that they choose can integrate easily with all the controllers in the system. The integration requirements demand that the platform used to integrate all the controllers is powerful, open and standard enough to stitch all the controllers together into a holistic system. Ideally, all controllers would run on a single PC to simplify integration, but at the very least, machine builders must embrace integration standards like VDMA for robot control integration and PLCopen to enable faster integration and more seamless execution.

Why should the platform be open and powerful? The development tools used to integrate the controllers must offer the functionality that matches a given task. If the task demands ladder logic, then PLC languages might be most appropriate. If a controller component requires an object orientation, then C++ would be most appropriate. For building the HMI to optimize the user experience, then maybe .Net or a 3rd party GUI development application like LabView would be appropriate. Conversely, it may not make sense to force a machine developer to use C++ to do ladder logic if that machine developer feels most comfortable with PLC logic. The point is that the optimal integration environment for building Industry 4.0-enabled machine control must support a wide variety of development languages to better match the requirements of the demands of the machine being built.

Most CNC controllers are closed systems that perform the entire task completely. But how can a CNC controller directly integrate with the Cobot and other machine automation if the CNC system is closed? More and more companies are considering PC-Based CNC controllers because the PC simplifies the task of integrating multiple controllers.

We must also look to the future, where smart factories will seek to deliver on the vision of mass customization (a batch of 1). For example, once upon a time, an auto company would build a factory for building 2-door cars and a factory for building 4-door cars. At Jeep today, 8 different models of Jeep – both 2-door and 4-door models – can be built on the same assembly line. Using Industry 4.0 concepts, Jeep depends on the cloud and a group of robots that can download the operating instructions to perform a weld on a 2-door car and then receive instructions to weld a 4-door car next. This takes tremendous integration and coordination but can be achieved like a concert, conductor and all the musicians playing from the same song book, all the robots executing from the same score that is delivered depending on model type.

This will not immediately lead to a lights-out factory. It is conceivable, however, because all the connectivity enables remote monitoring, remote management, and importantly, remote deployment. Engineers that design work flows for machined parts will soon be able to develop in the cloud and then deploy remotely.

Information Sharing and Intelligence Consuming

It is vital for Industry 4.0 deployments that CNC machines and controllers can be easily networked together. This requires adding support for standard communications protocols like OPC-UA, MQTT, TSN, Modbus and more. The ultimate goal with Industry 4.0 is to enable a CNC machines, robots and the other machines be self-aware enough and smart enough to plug-and-play into an Industry 4.0 environment. This vision will require an intelligent or smart controller.

In the Industry 4.0 model, the smart edge machine control will often do some pre-processing to aggregate and roll up data before sending to the cloud. Machine control is capable of dynamically changing the workload flow or parameters of the flow based on actionable insights but being dynamic is hard. The system must be very flexible to accommodate input and an open, smart, software-based architecture is the only approach that can deliver that flexibility.

Hardware-based controllers, CNC and PLCs with a fixed form factor are not able to run 3rd party analytics on data that is collected; data must be passed to a PC or other computing platform. Only a software-based CNC control software can optimize the information sharing and intelligence consuming process. The machine automation software that runs on a PC must be flexible enough to ensure that the RTOS can be assigned to certain CPU cores and that other 3rd party software can be assigned to other cores on a single PC yet support direct access to share memory. This way, both the control system and 3rd party can communicate directly and can operate on the same data. This is known as affinity masking and is far superior to virtualization techniques. Virtualization doesn't allow for direct share memory access but rather depends on buffering or mailboxing, which adds unneeded latency. Of course, latency reduces performance and quality.

Additionally, PC-based environment communication protocols come for free with the software. Hardware-based controllers often demand additional IO cards to accommodate various protocol connections at a charge, which is unnecessary.

Finally, connected systems increase the vulnerabilities for cyberattacks, so safeguarding the data and the machine control is paramount. Systems must have world-class security to protect against such threats. Using PC-based machine automation software that runs on Windows is now a safer bet because Microsoft has invested heavily to ensure that the OS and Azure infrastructure is super secure.

4. Smart Edge IoT Enablement

Edge computing is a method of optimizing cloud-based computing systems by performing data processing at the edge of the network, near the source of the data. Intelligent edge IoT machine controllers are an emerging example of how individual devices can be customized to function within a user's environment. Collecting CNC controller, sensor, IO, and drive data, executing locally predictive analytics, and 3rd party AI processing makes the whole system more responsive.

Additionally, often a machine controller will benefit from having 3rd party commercial software packages (e.g. business intelligence, AI, remote management or deployment release control) execute on the same platform. No machine control vendor can offer every functionality, so augmenting tools are always valuable. For example, Microsoft offers Azure IoT Edge that puts AI on the edge device.

Further, building machine controllers, CNC machines and a system of machines is time consuming, complicated, risky and expensive. Today, increased computing power and connectivity are making it possible to virtualize this "building" task by quickly creating and maintaining a digital representation, or "digital twin", of any real machine control, equipment or plant. The digital twin technologies become increasingly valuable as the system gets commensurately more complex. Before a machine or a system of machines is physically built or the first part is even machined, engineers will be able to leverage software-based visual simulation to understand whether the machine or part design is optimal. For instance, bottlenecks or collisions can be identified so the system can be redesigned to address flaws before the first system is physically built. Additionally, for a CNC system, the digital twin will allow customers to "mill" a part before it is physically cut. The engineers can evaluate different methods for milling the same part.

Of course, all the components must work in concert via a tight integration, so choosing the right software or technology to integrate and build an industry 4.0-enabling smart machine controller is critical to success.

In Summary: Industry 4.0 Requirements for Smart CNC Machine Automation

When reviewing the four feature sets needed to achieve Industry 4.0, it's clear that the only viable approach to deliver the flexibility required to integrate a system of controllers is one based on software.

In other words, Industry 4.0 can only reach its full potential when the system-wide integration of all the machine control is integrated, so choosing the right software tools or technology that can stitch the system of machine controls together seamlessly is the key to success. To summarize the four sections above, the features critical to that end include:

- **World-class machine automation technology**
- **The most open development and deployment environment that can enable cooperative processing with the cloud**
- **Machine automation technology that can generate insights with AI at the edge**
- **The ability to dynamically adapt and execute actionable insights**
- **The option to benefit from 3rd party applications that are co-resident on the controller**

While there are many subtle features in a machine automation development solution that can determine the ultimate success of an Industry 4.0 initiative, the machine builder, factory owner and machine controller designer should not lose sight of the fact that they are not selecting a widget that goes into a machine or factory. Instead, they are investing in a relationship with a partner who supplies the smart machine automation software that will last a decade or more.

Mission-Critical Feature that Predicts Success: Smart CNC Machine Automation Software

There is a common thread that makes it possible for a single machine controller to stitch all four requirements into a cohesive fabric of execution: that the controller must be built with software and deployed on an industrial PC (IPC). But not just any software. Machine builders will require standards-based, smart machine automation software that runs on an industrial PC and can concurrently run both the control system and 3rd party software that supports Industry 4.0 initiatives.

By contrast, proprietary hardware controllers (like name-brand PLCs or PACs or motion cards) are nice because of the fixed format and ease of use. However, they are completely inflexible for implementing Industry 4.0 initiatives. Hardware-based solutions quickly become islands of automation when a fabric of networked machines is required. These products can't run third-party analytics applications or communication applications. In fact, with hardware solutions, customers often need to pay more for additional i/o or communications cards just to plug into the network.

Worse, hardware-based CNC controllers are just that: hardware. The future is digitization of the machine so that the machine can adapt, take corrective action, or act dynamically on new insights while in production. Only an all software-based controller can deliver that kind of flexibility.

Remember, Industry 4.0 is really the digitization of the machine itself, which captures all the information about the machine and then shares that digitized data for analysis, improvement, corrective action and new products. Software is the only way to achieve this. But not all machine automation software is the same either.

Most software-based controllers limit the number of other controllers or 3rd party applications that can run concurrently on a single IPC. Also, most focus on supporting one language interface like PLC-languages or C++ or .Net, but not all three, without the ability to use the language that is purpose-built for the task at hand. Finally, many software-based solutions are not truly open because you can only purchase the industrial PC from the vendor that sells you the control software. Conversely, many software-based machine automation vendors do not let you run their software on competing PCs.

The bottom line is that only PC-based, standards-based machine automation software for Industry 4.0, which is based on a general-purpose operating system (GPOS) like Microsoft Windows and enhanced with a real-time operating system (RTOS) on that same IPC, can become the optimal platform for delivering on the promise of Industry 4.0.

A truly open machine automation software solution should be able to run on any industrial PC whose hardware is architected for industrial automation, with minimal system management interrupts. This type of machine automation software can:

- **Handle all the core motion control and determinism that machine automation demands**
- **Address the specific integration and communication tasks associated with Industry 4.0**
- **Rely on Microsoft for many critical features like security and AI**
- **Respond to actionable insights that return from the cloud**
- **Scale and support 3rd party packages that other software-based machine control technologies can't**
- **Serve as a smart edge device that is flexible enough to protect against unanticipated feature demands due to the minimal constraints of open, PC-based software**

One example of such a solution in the market today is **KINGSTAR** which is a standards-based industrial machine automation software solution for Industry 4.0.

The Key to Success: Embrace Digitization

Although international governments are embracing Industry 4.0, offering industrial policy and creating incentives, most manufacturers are adopting Industry 4.0 because they can see that it is changing manufacturing forever in the same way Amazon changed retailing.

The key to success is to embrace digitization throughout the entire manufacturing value chain. The cloud is important, but the cornerstone of Industry 4.0 is transforming the proprietary machine controller into a smart machine control platform that can create a smart factory enabled by Industry 4.0. To achieve this goal, CNC machine builders must rethink their machine control architectures, eliminate hardware-based islands of automation CNC machine control systems, and embrace IPC-based, standards-based CNC machine automation software for Industry 4.0. Smart, open software is the only foundation that can support all the features required to build the optimal platform for delivering on Industry 4.0's incredible promise.

MACH4 CNC: World Class CNC Controller That Benefits from Digitization

Newfangled Solutions offers CNC software and is home to the world-famous Mach4 CNC, which is Newfangled's newest version of the CNC control software. Mach4 was written from the ground up to be expandable, flexible, and extremely responsive for use with very large files. Importantly, it was also architected to plug-and-play into Industry 4.0 environments. But most importantly, at every level of the system, the engineering team wanted to create a way for people to codify the demands of the system without having to do any programming. They could re-design the HMI or capitalize on 3rd party software because the Mach4 solution runs on an Industry PC (or a regular PC for that matter!).

Competition is fierce in the CNC controller market because CNC machine shops are so price-sensitive. Especially in developing countries, CNC machine builders must forgo performance and quality if they want to offer lower-cost machines. To combat this challenge, Newfangled needed to distinguish their CNC machines by adding quantifiable performance and quality without commensurately increasing price.

As with any business, this was no easy task. What was the secret to Newfangled's success? They aggressively embraced industry standards. This strategy required two key components. Newfangled had to select the right fieldbus standard and design the right machine automation architecture.

	EtherCAT	EtherNet/IP	ETHERNET POWERLINK	PROFINET	sercos the automation bus
STANDARDS BODY	EtherCAT Technology Group	ODVA	ETHERNET POWERLINK Standardization Group	PI PROFIBUS • PROFINET	sercos international
TOTAL MEMBER COMPANIES (including non-ethernet members)	4800	300	250	1400	90
MANUFACTURING MEMBER COMPANIES	500	30	25	80	90
REAL TIME PART MFG	180	2	10	6	3
SERVO DRIVE COMPANIES	150	5	9	12	7
I/O COMPANIES	100	8	5	6	4

Source: Standards body websites, Wikipedia and Public presentations

STRATEGY: Choose the Right Digital Fieldbus

When selecting a digital fieldbus approach, Newfangled understood that a standard is only valuable if the market accepts and adopts it. As more vendors adopt a standard, the competition increases, and the prices decrease. After considerable research, Newfangled discovered that EtherCAT clearly stands apart from competing digital fieldbus standards.

EtherCAT met Newfangled's needs for a variety of reasons. They found that selecting a new digital fieldbus architecture based on Ethernet Category 5 (aka Cat 5) cabling and a more open, machine controller architecture could dramatically lower their costs and improve their quality. Importantly, proprietary wiring versus Ethernet cabling for machine control can be very expensive. EtherCAT also offers dramatic savings in effort to install, test or fix wiring when comparing a digital fieldbus as the standard versus an analog proprietary brand. Plus, communication to servos with a digital fieldbus is statistically more reliable.

Just as a point of comparison, Siemens CNC controllers largely standardize on PROFINET, but customers must also purchase all the components from Siemens or a limited market, so the price of the total solution is often substantially more.

SOLUTION: An All-Software, PC-based Approach

Newfangled knew that EtherCAT was a safe bet as the best digital fieldbus. However, as the old joke goes: The good news was that so many vendors offered EtherCAT, the bad news was that so many vendors offered EtherCAT. Newfangled soon realized that their real challenge was picking a machine automation architecture. They hoped that doing so would narrow the field of potential EtherCAT vendors that could support their CNC machine controller.

Since Mach4 is a PC-based CNC solution with a breathtaking user interface designer, it made sense to eliminate all DSP-based proprietary EtherCAT solutions for their architecture and remain focused on offering an all-software, PC-based CNC-software approach. They quickly found that only an all-software PC-based approach delivered on their long-standing promise of being cost-competitive without sacrificing quality. Mach4 CNC software on a Windows PC coupled with EtherCAT offered the best flexibility as well as best-in-class quality and performance. Even better, an all-software EtherCAT on a Windows PC can reduce the machine controller cost by more than 56%.

With their approach defined, Newfangled now faced the task of choosing the right vendors. First, they identified a set of requirements that would help them achieve best practices and get to market quickly.

- "Plug-and-play" capabilities for minimal configuration. EtherCAT can be complex to configure, so the ideal vendor needed to simplify the configuration process.
- A controller interface that runs on Windows, so it's user-friendly and easier to find developers.
- A real-time operating system (RTOS) that's market tested AND capable of running on the same Windows PC or a second PC.
- Mach4 also uses 3rd party motion boards but then the solution would not support EtherCAT or be an all software solution
- An RTOS without restrictions on 3rd party applications run on the PC.

While there were plenty of vendors that offered proprietary, hardware-based, EtherCAT-enabled solutions, there were only a handful of all-software packages that embraced EtherCAT and Motion Control and executed deterministically on a PC-based Windows system.

Mach4 CNC from Newfangled now relies on the KINGSTAR Motion Bundle, and the whole solution is stitched together with the KINGSTAR plugin for Mach4, which can be found at ECATCNC.com. This solution delivers an outstanding, Industry 4.0 CNC machine automation functionality and unprecedented ease of use. Further, it offered distinguishing features like a true plug-and-play EtherCAT feature, an architecture that transforms Windows into an RTOS, and the ability to run 3rd party software or controllers on the same PC. This flexibility protects Newfangled customers as demands for Industry 4.0 features arise in the future, such as IoT edge computing.

RESULTS: Higher Quality, Lower Prices, and Delivering on Their Promise

By selecting the KINGSTAR Motion Bundle for MACH4 CNC, Newfangled has created an exceptional Industry 4.0 CNC machine automation architecture that provides a quality and performance/price advantage now and will adapt to increasing demands in the future. The EtherCAT standard has proven to be the right choice because it lowers the cost of the components and enables breakthroughs in machine control while delivering operational and support benefits. One customer, Jose Moran at Mecano, reports that "Troubleshooting for wiring problems within the machine has become non-existent thanks to EtherCAT." Eliminating problems for customers like Mecano makes Mach4 that much more competitive and valuable. It just works.

Finally, Brian Barker, owner, feels that his Mach4 CNC machine controller is now set up for whatever the future might bring to his OEM partners. "Because our CNC controller evolved to a completely open architecture that is based on machine automation software and that can execute on an industrial PC, we have an approach that allows for the tailoring of the UI without programming, our customers will always be able to quickly capitalize on any disruptive changes that emerge from the market just like we are for Industry 4.0 right now."