Smart industry
SPECIAL REPORT

Robots, Cobots & You: Gaining a Competitive Edge with Next-Gen Tech

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Collaborative Efforts, Universal Gains: The Future of Robots in the Industrial Space

By Gareth Noyes, chief strategy officer, SVP strategy & corporate development at Wind River

Cobots.

The name is a union of "collaborate" and "robot" and the increasing popularity of these autonomous machines in the manufacturing space is a result of the benefits of that collaboration. Like never before, robots are working with—oftentimes alongside—human counterparts. And they're changing the modern industrial workplace.

Historically, industrial robotic applications deployed at scale have been geared toward mass production. In these scenarios the (historically expensive) robots are optimized for a specific task that can be carried out independently. These robots are normally physically isolated from people for safety, often by barriers or cages. Think of an assembly line which might have a robot that lifts and places material, another robot that can perform high speed and precise welds, and another that can paint beautiful blemish-free surfaces. These are traditional industrial robots. Steer clear!

Contrast this with cobots designed to assist or augment the capability of flesh-and-bone workers, whether guided by—or responding to—humans interacting with them to perform tasks jointly. These cobots share the same workspace as humans, interact with people (both deliberately or randomly), and move independently of their human co-workers. At the core of this newfound adaptiveness and responsiveness are increased levels of automation and a focus on enhanced safety considerations.

For the foreseeable future, these two distinct classes (robots, cobots) will likely remain, as there is additional cost and overhead in implementing the advanced capabilities of cobots. New skills come at a cost. As technologies mature and price-points reduce, however, it is likely that the distinction will become more and more blurred.

SO WHAT'S PROMPTING THIS SHIFT TOWARD COLLABORATIVE ROBOTS?

The factors are as varied as the tasks they can perform, enabled

Progressive business leaders are capitalizing on new capabilities afforded by cobotics and optimizing efforts on both the business and personnel fronts.

by emerging technologies (new computing power, cheap sensors, complex software) and propelled by business and personnel needs.

Business drivers boil down to efficiency (cost reduction or increases in throughput) or flexibility (moving from high volume/mass production to customized high mix/low-volume production).

Personnel factors include the demand for safe working environments (assisting workers in manipulating objects that could injure them), shortage of personnel with specific skills, and geo-political factors such as on-shoring.

Progressive business leaders are capitalizing on new capabilities afforded by cobotics—capabilities that were not possible with traditional robots—and optimizing efforts on both the business and personnel fronts.

MEET YOUR NEW COWORKER. (HE DOESN'T TALK MUCH.)

Production environments are the easiest way to envision how human workers are collaborating with robots. While material handling on a production line works well with traditional robots (be the materials as small as a computer chip or as large as an automotive chassis), some tasks, such as installing wire looms in cars, require both might and finesse. In such a scenario, collaborative robots assist workers by supporting the heavy weight of cables being installed, while responding to guidance from humans for detail work and placement.

Human judgement—an essential workplace asset that isn't going anywhere anytime soon—can be combined with automated tasks that improve precision, reduce errors and mitigate injuries.

If those benefits sound like significant ROI elements, you are correct.

NEXT-GEN COBOTS

Robots have historically been employed for automating tasks. The distinction with cobots is that we are using these "next gen" machines to execute tasks autonomously. That's an important distinction. While an RTOS like VxWorks is used as a robot's software "brain," software governing cobots must be expanded to ensure a higher level of safety and to enable the addition of further intelligence to increase machines' freedom, range of motion and number of sensors that prompt the machine to respond to its surroundings.

While these underlying technology elements will have to be built into the system, ultimately it is the ability to make a more flexible and responsive system that will define the cobot as being "next gen." Here we rely on advances in machine learning related to object recognition or problem solving, in addition to basic, reliable, safe control functions.

All of this changes the underlying software architecture required to build cobots. Here at Wind River, this entails a combination of traditional embedded technologies, such as VxWorks, working in tandem with general-purpose computing environments, such as Linux, to enable a modern approach to programming and the deployment of new technologies such as Tensorflow or OpenCV for machine learning and image processing.

COBOT EDUCATORS

This is all heady stuff. New to many, even the smartest minds in industry. So there remains a great deal of confusion about cobot implementation in the manufacturing world. *How do they work? What do they cost? How would my enterprise benefit from some newfangled machine that controls itself?*

While the capabilities of modern robotics are generally well-understood among business leaders, the accessibility and availability of cobot systems isn't. The perceived complexity can be overwhelming. There might be a lack of skills to make use of and deploy these systems (though a pool of talent for outsourced help is increasingly available). Another aspect is affordability, which becomes better year after year.

These factors must be communicated to executives pondering cobot initiatives. They are common concerns with attainable solutions. Ultimately, deployment of cobots is most often limited by a compelling business case to do so. And in high-volume markets (consumer electronics, automotive manufacturing) there are compelling opportunities to do so. Flexible manufacturing, where consumers can customize their sneakers or their entire car, rounds out the other end of the spectrum; cobots and higher degrees of flexible manufacturing can drive real benefits. Naturally, large enterprises with deep pockets are implementing robotic infrastructure at a faster clip than smaller businesses lacking the domain knowledge to be early adopters.

COBOTS 101

We at Wind River are happy to play the role of educator—Cobots 101. While our customers (OEMs, system integrators) oftentimes educate end users on how and when to deploy cobots, our role is to showcase how to easily implement and deploy the underlying technologies and software to enable the creation of autonomous systems featuring cobots. As with all advances in technology that have the potential to impact humans, demonstrating how to create systems that are secure, safe and reliable is paramount. Wind River can rely on 35 years of doing just that.

REAPING THE GREATEST (COLLABORATIVE) REWARDS

As I mentioned, industries that are driven by mass-market applications are most aggressively leveraging advanced robotics currently. Cobots and the democratization of intelligent-autonomous systems is enabling those agile, customizable manufacturers to get in the game, reaping benefits from robotic systems that will only grow more collaborative, more lucrative over time.

Traditional manufacturing sectors such as consumer and automotive will dominate this trend in the short-term, but the drive to flexible, optimized supply chains will soon make robotics/cobotics more prevalent across industries; consider niche applications like search-and-rescue or emergency response to situations such as toxic spills that will emerge as a result of the growth of intelligent, collaborative robotic systems.

Now, while it is tempting (and fun) to ponder new features and capabilities of cobotics, the true mark of success will be the increased deployment of autonomous systems that drive unforeseen flexibility and productivity, all while making the workplace safer. (See my colleague Ricky Watts' deep dive into safety later in this report.)

I am thrilled to see the spill-over of robot/cobot technologies and knowhow across applications. Just consider the recent explosion of artificial intelligence as a practical tool! I am excited about a future where robots and cobots provide us exponentially productive industrial environments that boast unprecedented safety.

And as we progress down this path, the distinction between the two terms should fade as collaboration between man and machine evolves. In fact, that term—cobot—might just replace its predecessor entirely.

"Hey boss," asks the new employee on the factory floor of the near future, where autonomous cobots seamlessly work alongside him, "What was a robot?"

Computer Vision Changes the Scope of Industrial Robotics

THE CHALLENGE

The first industrial robot was invented in 1954 and was installed seven years later in a General Motors factory for spot-welding and die-casting. Since then, robotic technology has been used in industries from manufacturing to agricultural farming as a means to increase efficiencies, lower costs, and increase revenues. These robots are usually designed to work independently, executing pre-scripted tasks in spaces protected from human interference. They have increased factory productivity, but traditionally limited capabilities.

Cobots, or collaborative robots, are a new step in industrial robot technology. Unlike most robots, which act as replacements for human workers (and often operate in cages to prevent injury to workers), cobots are designed to work side-by-side with their human counterparts, even collaborating on the same task. How do these robots gain new abilities that can increase their operational value while remaining safe and secure as they operate in a factory near humans?

THE APPROACH

One way to increase robotic abilities in a safe and efficient manner is to use an innovative new technology: computer vision. This technology enables a robot, or computer system, to use a camera or scanner to transform multidimensional inputs into data it can process, “perceiving” its surroundings and mimicking sight. Computer vision coupled with machine learning gives the computer increased technical abilities and the opportunity to perform more complex tasks. Robots accessing computer vision gain abilities beyond scripted tasks and can augment the abilities of their human coworkers by participating in their labors or by using technologies such as infrared imaging to see and report on things invisible to the human eye.

This technology dramatically increases the potential for robotics in industry, creating avenues that would not otherwise be viable. For example, using an AI-enabled cloud, connected robots could recognize objects faster and send collective messages, notifying or warning humans of situations that they could not see. They could also aid in quality control, as they could be able to recognize the condition of products when compared against the expected visual representation.

Similar advantages could pertain to agricultural production. Independent robots using computer vision could differentiate between product quality levels; for example, the robot could use imaging types in both visible and ultraviolet light to detect below-surface discrepancies and extract a higher profit from varying products by identifying food grades. It could even warn for diseases, such as peach leaf curl on trees, that would significantly reduce productivity if not treated.

WIND RIVER TITANIUM CLOUD

Adding new technologies would enable the machines to do more, but new approaches would be required, including a virtualization system

Computer vision coupled with machine learning gives the computer the opportunity to perform more complex tasks.

to enable the running of multiple applications. Wind River Titanium Cloud is a portfolio of virtualization software products that can meet this need, enabling a cloud infrastructure for robotics applications. Implementing an ultra-low latency system such as Titanium Cloud, coupled with advanced 5G technology, would allow robots to communicate with one another almost instantaneously, sending data throughout the factory and creating a cohesive, connected network to further streamline production.

VxWORKS

The VxWorks real-time, deterministic operating system enables rapid data processing for real-time actions that will allow robots to work reliably and consistently in close quarters with human employees. The robot would be able to rapidly process data, including potentially dangerous changes in its environment, and immediately respond to them. VxWorks supports the ROS 2 operating system framework, a re-architecture of the original ROS framework, enabling use cases such as teams of multiple robots and production environments on a real-time platform.

OPENCV FOR VxWORKS

Implementing computer vision can be a daunting task, as it takes thousands of lines of code to allow computers to process sensory data. However, Wind River offers a modification of the open source computer vision library, OpenCV, optimized for VxWorks. With more than 22,000 commits and nearly 800 contributors, OpenCV for VxWorks includes algorithms to recognize faces, classify human actions, identify and track objects, track camera movements, and more, adding complexity to robotic software without increasing development time.

WIND RIVER HELIX VIRTUALIZATION PLATFORM

Wind River Helix Virtualization Platform is a virtualization technology that uses a Type 1 hypervisor. It is based on VxWorks, so it can enable a real-time virtualization platform to run multiple applications in virtual machines for new robotic functions. It can provide a foundation for operating a cloud-based artificial intelligence that can provide data-driven decisions for robotic operations in a factory. Helix Platform allows multiple coding environments to exist in the same system, operating as independent virtual machines on a single compute platform.

Helix Platform in conjunction with Titanium Cloud would create a low latency system with the safety, security, and reliability required in critical infrastructure environments. Moreover, they can work with VxWorks to create a cohesive real-time environment to incorporate computer vision and 5G in a cloud-based system, while maintaining elite cybersecurity standards.

THE RESULT

Currently, industrial robots harbor many potential safety dangers, as they have no awareness of their surroundings other than what is provided by sensors; this could cause serious harm to people working nearby or alongside them. However, with the addition of new sensing technologies, robots could be used in closer proximity to humans and in more confined spaces, so that factory workers and robots would be able to safely work in tandem.

Both the production capacity and the safety of the factory could increase. Robots could perform more complex tasks, and they could operate in a disordered space by recognizing the objects they should interact with.

Wind River offers solutions that incorporate the latest ROS 2 framework, so developers can focus on application development, leading to more innovative robotics. Compute and partitioning capabilities can protect safety applications while providing the high performance that is important to enhance further collaboration between humans and robots.

To learn more about Titanium Cloud, VxWorks, or Helix Platform, visit the Wind River website or contact our sales inquiry desk.

What Makes a Robot?

By Chris McNamara, Smart Industry content director

Contrary to technological trends that germinated inside factories and made their way out into the wider world, manufacturers are increasingly being influenced by the wider culture. This is a good thing. Consider the prevalence of smart thermostats—automated regulation of the home space that can be applied on a grander scale in industrial settings.

Just as Gareth Noyes described the waning distinction between robots and cobots earlier in this report, so too is the distinction between man and machine lessening. Not in some creepy sci-fi way, of course. But consider robotic elements being employed in manufacturing. Smart skeletal frames are currently lending manual laborers added support and strength. Or think about smart glasses, with software-enabled frames as small cobotic elements.

As robots are changing, so is our notion of what, exactly, a robot is. We're widening the definition, just as robots' skills and abilities widen.

I recall a recent discussion about factory-workers' perception of robotics, during which a young engineer made the comparison to a tool—an electric drill—as he quickly, easily programmed a robotic arm to perform a task. The engineer's argument was that, rather than the reluctance some workers feel about the introduction of robots into the workforce, our metallic counterparts should be considered mere evolutions of labor devices, just like the electric drill, which never replaced anyone's job.

Nobody ever feared an electric drill. In fact, drills make workers more productive, safer, better. Just as robots are increasingly doing.

Like most technologies, robotics are only getting smaller, cheaper, faster. As a result they're being adopted at a quicker and quicker clip. Their applications in the industrial space are booming. The software empowering them is blossoming. Demand is exploding.

WHERE ARE WE HEADED FROM HERE?

The best indicators might be the solution providers—those making the robots and the cobots and the software governing them. Solution providers are betting big. Progressive business owners are buying in. And I, personally, find prognosticating the future of robots terribly exciting.

Forgive me if that sounds terribly human.

Safety for the next generation of robots

As the use of robotics expands in the manufacturing world, collaboration between robots and humans will evolve. Safety will become critical. Caging robots is no longer the only approach...at least for those manufacturers looking to take full advantage of this amazing collaboration.

ASSESSMENT OF ROBOTIC SAFETY NEEDS

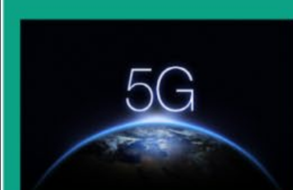
Key to safe robotic operations is assessing the interaction of humans, robots and the surroundings. Modern robotic systems must address all potential robotic/human interaction scenarios with safety as a priority.

TAKE ADVANTAGE OF NEW TECH

Technologies such as 3D sensors, stereo-vision cameras, separation monitoring and force regulators can make next-gen robots safer for collaboration with humans.

CAPITALIZE ON SHARED CONTROL

Some operations and working environments can exploit the benefits of shared human/machine control over work processes, such as robotic surgical machines. Consider shared control in your product plans.



IMPLEMENT 5G CAPABILITIES

5G can expand robotic capabilities and collaboration with quicker video, faster data analysis, hi-def image streaming, low latency, high throughput, remote safety and true edge computing. Explore 5G capabilities.

CONTACT WIND RIVER

To explore how Wind River can help your company make robotics safe and secure, email Jeff Kataoka at Robotics@WindRiver.com

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Your New Coworker is Safe, Secure…And a Robot

By Ricky Watts, vice president, industrial solutions with Wind River

Consider the difference between safety and security.

Broadly we think of safety as ensuring that systems don't harm the world and security as ensuring that the world can't harm the system. Make sense? These are symbiotic concepts, and can be addressed by some common approaches—isolating access to parts of the system, halting execution if a breach or failure is detected, etc.

In that respect, safety and security are well-trodden topics. We've been doing this stuff for years. But the introduction of advanced, collaborative robots into the industrial space is changing the rules. New capabilities are demanding new levels of precaution.

With traditional robots it was easy...you isolate them. You put them in a cage or make sure the humans don't go near the swinging arms.

But isolation undermines the greatest value of cobots—collaboration. Collaboration with human workers demands proximity, an industrial intimacy if you will. As such, cobots must be designed in such a way that the system is safe when they're working with humans. Similarly, there is a fundamentally different approach to systems engineering and software development when the workforce includes cobots.

We've been doing this stuff for years. Wind River adopts practices for robotic applications that it has used elsewhere, when building flight-management systems or developing software for autonomous vehicles. We are helping to architect and build safe systems—systems that capitalize on the tremendous capabilities of modern robotics—that adhere to regulations and standards that are defined for modern industrial safety and security systems.

A thorough risk assessment needs to be evaluated that contemplates the scenarios in which a robot will operate.

OF COURSE, IT'S TRICKY.

There are several design factors that need to be considered when designing robots. At a high level, a thorough risk assessment needs to be evaluated that contemplates the scenarios in which a robot will operate, and the modes in which a human is allowed to operate within those scenarios. Failure modes of normal and unexpected operation need to be evaluated such that the likelihood and consequences of failures minimize potential harm.

In practice this means being rigorous about defining safe ways of working with robots, providing physical barriers, visual/auditory alarms and warning for feedback, limiting the robot's ability to do harm when coming into contact with obstacles such as shelves or steps or Shirley.

Similarly, the software required to operate these systems needs to be designed with system safety top-of-mind. Safety-design reviews must be performed to identify possible failure modes and ways to mitigate them, and to ensure that software has been proven to perform the desired actions. This approach to software development often requires a change to the underlying architecture implementation, as well as the development and validation processes. It also requires personnel willing to think in a manner they might not have thought before.

THE GREATEST SAFETY CHALLENGES

Robots have the potential to harm people throughout their lifecycle. This includes how the robots are designed, installed, operated and managed. Each of these requirements open up a possibility for a safety or security concern that could lead to a compromise in safety. This is especially true with high-powered systems or those that move at high speed. But alongside those obvious red flags, engineers must also consider every other design element, for example minimizing sharp edges or motions that could cause pinching.

The design of these safe systems must start with a thorough risk assessment and defining the modes in which robots and humans will collaborate. Design principles must be explicit in considering the real-world working environment, such as ensuring that a visual indication is provided for when a robot is in collaborative operation.

Engineers need to carefully consider the speed of robot operation, and carefully plan behavior based on well-defined areas or depth of separation from humans (how far apart man and machine are). Likewise, robots must be responsive to changing situations and able to limit the force employed in actions based on situations.

At the heart of the smart industrial enterprise is a secure, safe and reliable operating system with software efficiently executing the design parameters detailed above; a system that keeps workers of every sort safe, secure and productive.

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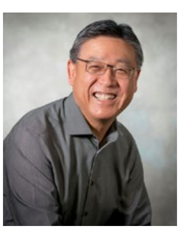
Wind River®, a leader in embedded software, delivers the technology and expertise that enable the deployment of safe, secure and reliable Industry 4.0 systems.
Learn more here.



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