

Hurco & IntervalZero RTX: Partners in Windows-Based Embedded Real-Time Control for More Than a Decade

The background and challenges:

Hurco is a US-based global industrial automation company that designs and produces interactive computer controls fitted to its machine systems for the metal cutting and forming industries.

In 1984, Hurco pioneered and patented the use of interactive graphical computer control systems that automate shop floor processes, beginning a period of sustained evolution, innovation and progress that has led to today's WinMax® controller.

Hurco's desire to produce interactive controls capable of meeting the hard real-time constraints of a motion control application while providing end users with a graphical interactive interface, led the company to explore technologies that could deliver hard real-time performance while simultaneously providing users with the most intelligent, efficient and user-friendly computer numerically controlled (CNC) metalworking machinery available.

More than 10 years ago, Hurco selected IntervalZero's RTX real-time software as the unique enabling technology capable of delivering hard real-time performance in an environment that co-exists seamlessly with Windows.

IntervalZero's symmetric multiprocessing-enabled RTX software transforms the Windows general purpose operating system into a real-time operating

system (RTOS). Proven and trusted at hundreds of customer sites world-wide in the Industrial Automation, Digital Media, Test & Measurement, Medical and Mil/Aero markets, RTX is a key component in a RTOS Platform, which also comprises Windows and x86 multicore multiprocessing and can include third-party value-added components such as real-time Ethernet.

Over the last decade, Hurco has continuously evaluated and compared competing technologies, but IntervalZero's commitment to excellence and continued innovation of the RTX product have kept pace with advances in Hurco's control software such as UltiMotion®.

"Innovation is a part of the Hurco culture, meaning that we think cleverly about technology and how it can benefit our customers. With IntervalZero, Hurco has a partner that also embraces this philosophy.

"As processor technology evolved, IntervalZero and RTX kept pace with the changes, ultimately introducing SMP technologies, allowing Hurco to take increasing advantage of improvements in processors," said Greg Volovic, Hurco's Executive Vice President, Technology and Operations

"Hurco is our Partner as much as they are our Customer," said IntervalZero CEO Jeffrey Hibbard. "Hurco has educated us over the years, helping us

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understand their market requirements and, most important, being very clear on what matters to their customers. As they've driven to continuously improve their market-leading products, they've provided valuable guidance that has made RTX and our RTOS Platform much, much stronger."

Hurco's relentless pursuit of performance improvements and the decision to select IntervalZero RTX

Hurco's first interactive controller was introduced in the mid-1980s and used the VRTX RTOS. That RTOS met Hurco's real-time requirements, but it was not a programmer friendly environment for building an interactive, conversational control platform that supported CAD/CAM-like functionality on the CNC.

By the early-1990s, the need to code user interface and graphics functionality within the RTOS was becoming increasingly complex and counterproductive. In searching for a better approach, Hurco evaluated a dual-CPU solution – one CPU to run an RTOS and the other for Windows, but this was not cost effective.

Other possible solutions included implementing the controller in ring 0, kernel-level codes – i.e., a custom device driver. Just like the inefficiency of developing user interface elements within an RTOS environment, achieving the deterministic code functionality provided by an RTOS under Windows forced Hurco's software team to work in areas outside of its core competencies of interactive design, trajectory planning and motion control.

Re-focusing on core strengths, Hurco evaluated various real-time operating systems, including VXWorks, Windows CE, INtime and IntervalZero's RTX.

Two were quickly ruled out. VXWorks lacked a seamless integration with the Windows environment; Windows CE, in addition to being API incompatible with normal Windows, failed to meet the performance requirements of Hurco's application.

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TenAsys' INtime and IntervalZero's RTX were the only two platforms that co-existed with Windows. Though both products appear similar at first glance, Hurco deemed IntervalZero's RTX preferable as it is the only true extension to Windows.

By augmenting Windows, RTX maintains control over IRQs, I/O, and memory. RTX was designed for speed

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and determinism, the fundamental building blocks for real-time motion control applications.

Moreover, because RTX does not encapsulate Windows, there is an efficient seamless integration between the real-time applications and Win32 software components running in user mode, improving performance by eliminating OS context switches.

As an embedded systems developer that is heavily dependent on both real-time and user interface applications, Hurco found that RTX provided the best fit.

“When managing a software team that must marry a real-time machine control with an intuitive user friendly interface, it is challenge to find developers that can effectively work in both these worlds.

“With RTX’s use of common Windows API’s, the seamless interface between Windows and the RTX real time environment, and through the included tools and utilities provided to analyze and optimize the system, our embedded developers and creative user interface types can focus on what they do best and do not have to stress about how it will all come together,” said Elias Pavlakos, Hurco’s Director, Software & Controls Technologies.

The bottom line for Hurco: RTX’s unique qualifications and the Customer experience

As Hurco’s RTOS needs have become more demanding over the years, IntervalZero’s commitment to innovation has not only kept pace with the company’s needs but has also yielded new options that enable Hurco to think innovatively about motion control.

Hurco’s proprietary UltiMotion® system takes advantage of the hard real-time environment provided by RTX to shift control algorithms from dedicated hardware into the software-based controller.

By monitoring system states, positions and velocities each control cycle, Hurco’s UltiMotion® system’s response to state changes, external disturbances and asynchronous user input has improved twenty fold.

One example of this is Hurco’s advanced power loss part protection mechanism, which detects a power outage and changes the control strategy to retract the tool from the part surface, preventing damage within the 300ms window in which the motors commutation field decays to the point where control is lost. This eliminates the need for an expensive multiphase power backup system for the servos.

“When software interfaces with the real-world, such as with a CNC machine tool, the ability to respond to the unexpected is critical to protecting equipment and end users. RTX’s support for low latency deterministic interrupts and its robust support for I/O operations enable software to not only see these events and respond appropriately, but also often to recover and continue operating. This is a much better option than dealing with the real world in hardware where a system shutdown is often your only solution,” said Song Liu, Technical Manager, Motion Integration & Servos.

Other examples of how UltiMotion® benefits from RTX’s hard real time performance include a 5-axis coordinated master-slave tapping control. Instead of the axes and spindle following independent, time-based motion profiles, the axes track the spindle’s actual position guaranteeing tight coordination between the spindle and the axes even while feed and speed overrides on the control are adjusted by the operator.

RTX has enabled Hurco to shift many aspects of the controller from dedicated hardware into software including – dynamic variable look ahead; double arc smoothing; dynamic model compensation; jerk control, and machine geometry compensation.

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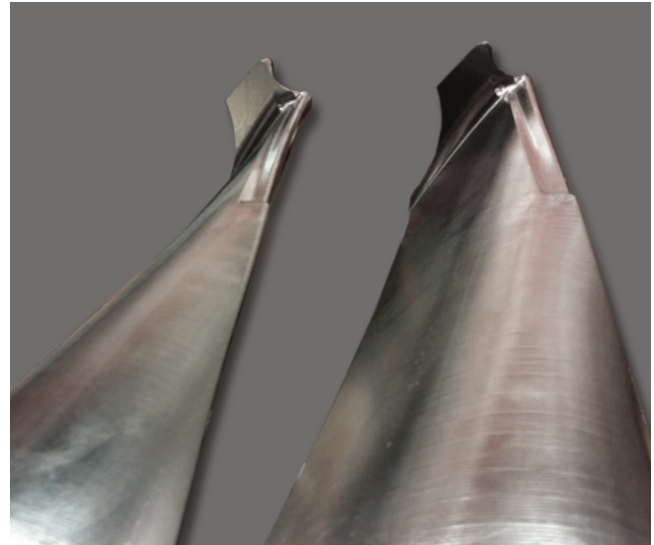
By building a smarter software-based controller on top of RTX, many of Hurco's customers have realized significant – 30-40% – improvement in throughput by upgrading to the UltiMotion® software.

The picture on the right shows a part machined using the UltiMotion® software on the left, and on the right is the identical part machined on the previous generation software.

UltiMotion® completed the part in 1 hour and 40 minutes with greatly improved surface quality as compared with the previous generation software, that required 2 hours and 20 minutes (shown on the right) – a 40% gain in throughput.

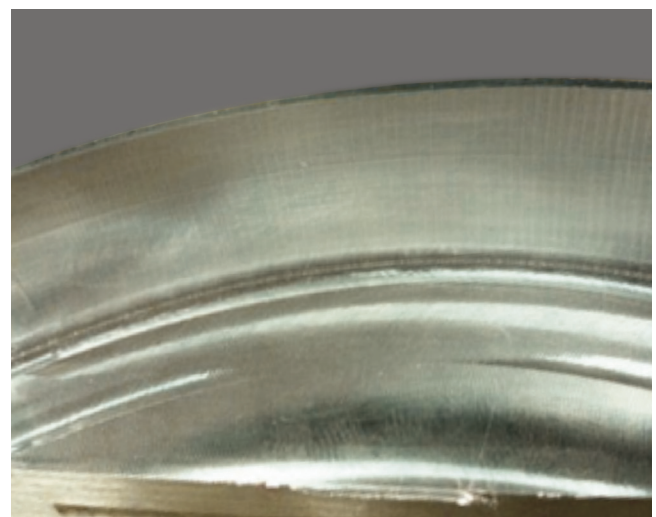
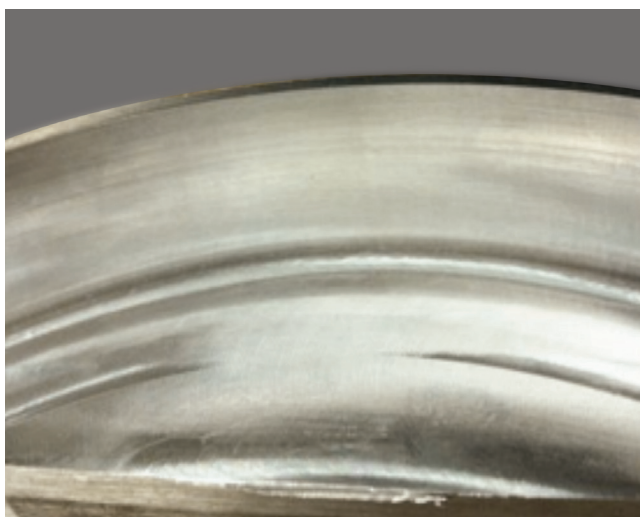
Another Hurco customer commenting on UltiMotion® wrote to the company: "We are very pleased with this software. Our first part to run is a 3 axis contouring part that we have been making for the past 3 years. The cycle time was reduced from 1 hour and 15 minutes to 50 minutes".

This was accompanied by the photos below showing the UltiMotion part on the left and the previous generation software on the right.



Hurco will continue improving its CNC system, leveraging the latest technology advances in RTX along with digital field bus technologies such as EtherCAT, SERCOS and Mechatrolink.

Hurco is evaluating 64-bit RTX under Windows 7 and IntervalZero's symmetric multiprocessing technology for use with a multi-core real time motion solution. It is anticipated that the digital servo system will improve the precision of the control and more importantly have



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the deterministic performance necessary to enable the controller to process more information from the drives and make smarter decisions.

As these benefits are realized on IntervalZero's RTX platform, the next level of performance for Hurco's customers is only a software upgrade away.

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