Best Practices for Real-Time Machine Automation Performance in IoT & Industry 4.0:

How IntervalZero's RTOS Platform Transformed Machine Automation in Japan

InapcyalZero

SUMMARY

Around the world, IntervalZero's real-time operating system (RTOS) is used by a multitude of customers with prestigious brands in dozens of different industries like industrial automation, manufacturing, mobile devices, digital media, medical systems, simulation, aerospace and defense. For the purposes of this success story however, we will focus on IntervalZero's best practices from 4 of our customers who represent the most recognizable SMT brands in Japan. It highlights the industry-level challenges they faced, the resulting machine automation and motion control requirements that needed to be addressed, the results they achieved and the key platform strategy that allows these customers to distinguish themselves in the ever-present IoT and Industry 4.0 worldwide market. The success story concludes with why the IntervalZero RTOS Platform makes the most sense for companies in the SMT industry and beyond.
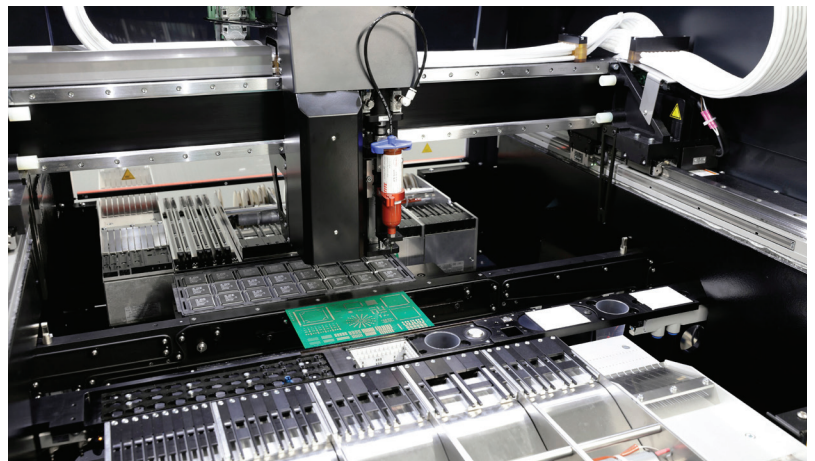
SMT OVERVIEW

On a substrate like a green printed circuit board (PCB), surface mount technology produces electronic circuits on which surface mount electronic components are placed. This technology is very different from the traditional thru-hole soldering method. This is because SMT equipment uses different soldering principles - more like gluing the component on the substrate with conductive material - and hence offers more electrical conductivity than its traditional thru-hold soldering counterpart.

The global market for SMT equipment is strengthened by the rapid expansion of the electronics market. This is being driven by the ever-increasing demand in the 3 C industries – computers, communications and consumer electronics - for 3G & 4G telecom networks, consumer electronics, LED and CFL lighting, and LCD/LED monitors and televisions, and more. The demand for surface mount technology equipment is also rising in response to the need for more efficient and lightweight electronic devices. Add that to the already existing growth in the medical and automotive sectors, and the surface mount technology equipment market is poised to surge exponentially.
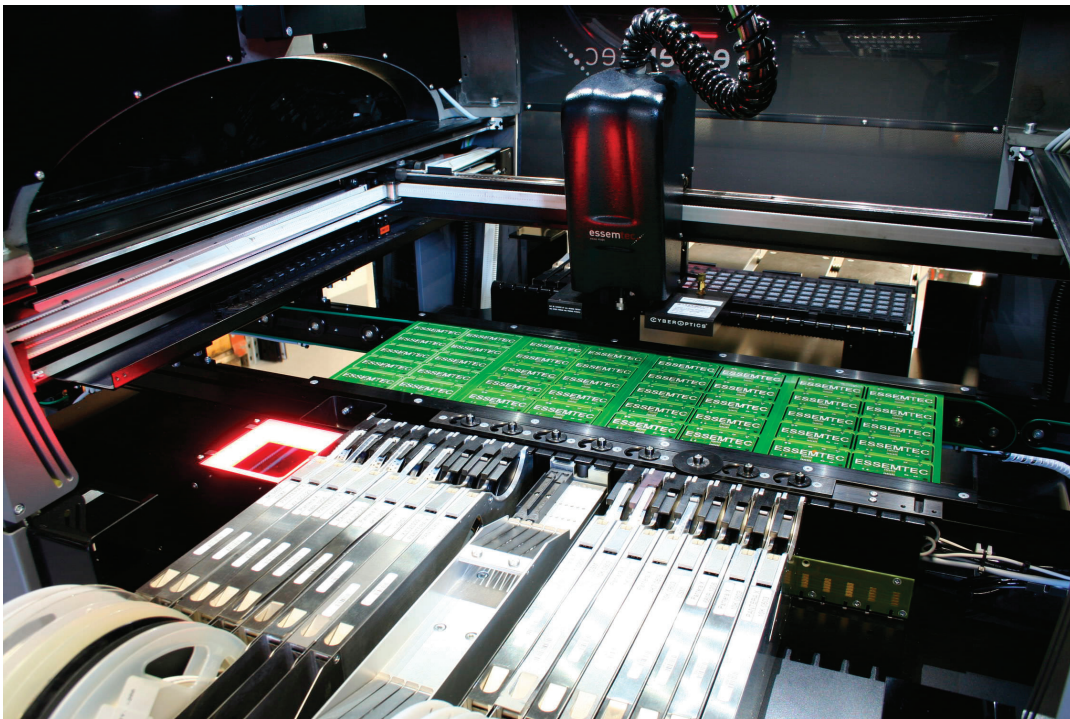
Repairing products manufactured using SMT equipment is difficult and requires highly skilled personnel and specialized tools. As a result, quality is absolutely paramount. Greater packaging complexities (e.g. miniaturization and dual sided mounting) coupled with tightening soldering quality requirements are bolstering the demand for sophisticated inspection processes to ensure efficient product control and low overall repair costs. To achieve the quality goals, the use of and innovation of automatic optical inspection (AOI) and x-ray equipment is increasing too. Inspection must be done while the process is happening and not just via testing after the SMT operation is complete. This ensures quality and improves yields, because issues are addressed sooner.

Relying on real-time machine vision dramatically improves the accuracy of the placement and thus the quality of the packaging of surface mounted devices. Since every company must overcome the hurdle of high quality, it forces enterprises operating in the market to focus on product innovation to enjoy sustainable growth and competitive differentiation.

Besides quality and miniaturization, the primary dimensions of innovation are machine setup time, diversity of part and board handling, and throughput performance. For instance, some shops run the same job continuously with only a single setup, and focus on component placement per hour (CPH). Performance is impacted by component feeder systems, the number of arms, heads and nozzles that pick the part up and place it, and the integration of the motion control, vision systems, and communications. By contrast, other shops run a variety of jobs, so performance is still important, but setup time becomes a more important dimension of differentiation. Solutions like modularity where multiple machines can be connected to execute different jobs become an elegant solution.

But that is not all. Cost is a major issue. The global SMT equipment market is highly competitive. SMT machine capacity is growing faster than the market demand. Owing to the presence of significant entry barriers, the margins in this industry are very low.

KEY SUCCESS FACTORS

There is no shortage of requirements that make the SMT machine competitive in the market. The industry requires considerable investment in research, since the turnaround time of the technology is very low; thus, enterprises operating in the market need to regularly invest in product innovation. Being so competitive, requiring such massive investment and facing low margins, any miscalculation or misstep can be very costly.

Key success factors include:

QUALITY

- Accuracy of component placement
- High yield of overall PCB

HIGH PERFORMANCE

- High yield - percentage of boards successfully completed
- High throughput – components per hour, boards per hour
- Flawless motion control

EASE OF USE

- Touch screen user experience
- Minimal physical setup
- Allow customer to improve speed to market

FLEXIBLE, SCALABLE, ADAPTABLE AND EXTENSIBLE

- Modular to scale with operations
- Deterministic communications within the equipment to motion controllers
- Reliable communication between equipment modules in assembly line
- Allow internal revisions of machine to get to market faster

SPEED TIME-TO-MARKET

- Address key trends like miniaturization
- Capitalize on machine consolidation trends – motion, PLC, vision for accuracy and vision for inspection (AOI) on a single machine

LOW COST

- Margins are tight
- Effectively, as equipment gets more efficient, fewer are needed, so competition increases

The RTOS Platform Strategy

Given the massive investments and low margins, how do these Japanese SMT machine builders consistently hit their marks, especially given that the industry requires considerable investment in research due to the long turnaround time of the technology? The 4 best SMT companies in Japan have developed an answer: their own version of a soft motion control platform strategy for machine automation.

The general concept behind the soft motion control platforms at these Japanese companies is that they developed a component-based motion control framework for machine automation that can be adapted with each innovation or each new demand from the market, while protecting as much of their existing investment in machine automation and motion control as possible. It is as easy as adding a new component that plugs into the platform to address the new feature, such as a new servo drive or an added vision system.

A component-based architecture like IntervalZero is so versatile, scalable, and adaptable that companies that choose RTX64 can continue to deploy their base application for decades without a major rewrite, just component rewrites as standards change. This means that instead of becoming outdated, the performance and machine output quality of the RTX64 application can increase proportionally as the PC gets faster. This outcome is in sharp contrast to companies that rely on DSPs, FPGA, or MCU architecture, who must rewrite their entire applications from scratch (not just components) to get the next level of performance and quality.

Being so cost-conscious, these SMT companies built their soft motion control platform on a Windows-based 64-bit industrial PC. This allows them to deliver a world-class user experience, to ensure that they have the lowest hardware costs (especially when contrasted to proprietary DSP or FPGA motion controller costs), and to take advantage of standard, commercial-off-the-shelf (COTS) communications.

Their equipment needed a real-time operating system (RTOS) capability, so they selected IntervalZero's RTX64 product. IntervalZero lets them run the RTOS on the same PC as their Windows IPC. Because the IntervalZero RTOS is SMP enabled, the SMT equipment manufacturers can add multiple components such as motion control, machine vision systems, software PLCs and more functionality just by allocating more cores of a PC to the IntervalZero RTOS for deterministic execution. This flexibility and extensibility allowed the SMT builders to address new miniaturization and consolidation requirements, for example, by simply increasing the number of cores on the PC and allocating more cores to the IntervalZero RTOS.

In most cases, these companies worked with specific servo drive, PLC, and machine vision system manufacturers who provided field engineers to help tune and optimize the performance of the system. The motion control platform, while flexible, was more purposefully built for their target environment around their motion control infrastructure. But the key to their success in addressing the industry's key success factors was implementation of the soft motion control platform.

Worldwide, IntervalZero customers in the SMT equipment market are faced with a new industry trend that must be addressed if they want to remain competitive. Real-time, deterministic, Ethernet-enabled fieldbuses are creating a breakthrough on three very important dimensions.

Real-time Ethernet standards like EtherCAT for motion control and GigE for vision are delivering:

- Improved quality
- Increased throughput performance
- Dramatic savings in costs

This trifecta of the 3 most important points of differentiation in the SMT market is precipitating a review of the soft motion control platform architectures. Most of our customers have embraced a single source for their servo drive infrastructure so that the equipment could be optimized. With EtherCAT and GigE, vendors can be mixed and matched, there are no proprietary IO cards and network cables – just Ethernet. For more information, read 5 Real-Time Ethernet-Based Fieldbuses Compared.

To get the optimized value from these real-time Ethernet standards, customers are now evaluating and embracing the IntervalZero RTOS platform. This platform offers all the benefits that our customers in the SMT market have enjoyed for a decade or more but in an open, standards-based, plug-and-play model. So rather than depending on a single servo drive manufacturer, the equipment builder can apply the right servo to the right job instead of underpowering or overpowering one of the operations because they are locked into a purpose-built platform.

Customer Spotlight

One of the world's top 5 SMT equipment providers, headquartered in Tokyo, Japan, relies on IntervalZero to streamline its manufacturing facilities around the world. With products in more than 170 countries on six continents, this SMT company must optimize costs, efficiency, and productivity. IntervalZero enables this manufacturer to not only remain competitive, but drive the innovation that keeps them at the top of the market.

Like our customers' implementations, IntervalZero has a subsidiary brand for industrial motion control called KINGSTAR. KINGSTAR runs directly on the PC, but it saves money because it uses the NIC card for I/O and uses the powerful EtherCAT protocol to free you from the shackles of proprietary and costly hardware. With KINGSTAR Soft Motion, motion control engineers can design, develop and integrate PC-based machine controllers in a "plug-and-play" environment for consolidated, inexpensive and scalable motion control.

RESULTS FROM IntervalZero SMT CUSTOMERS

With IntervalZero, Japan's leading SMT companies have achieved significant, measurable results. IntervalZero allows all SMT customers to stay ahead of the technology curve with respect to quality, precision, miniaturization, yield, component diversity, board size variation, and performance, all of which translate to the ability to successfully deliver world-class machines. While different metrics are more or less relevant to different organizations, every customer outperformed the previous generation or competing equivalent SMT machines that did not run the IntervalZero's RTOS Platform.

On average, SMT companies using IntervalZero can expect:

Cost Reductions	**25% or more reduction in cost** of overall motion computing infrastructure
	$1,230 reduction in direct computing costs per SMT machine with only IntervalZero RTOS
	Approx. $3,620 reduction in direct computing costs per SMT machine with KINGSTAR PLC, Soft Motion, and EtherCAT
	$5,000 annual reduction in indirect costs per machine due to easier assembly and maintenance
	Ability to execute vision and laser systems on the same compute platform, **reducing cost by an additional 25%**
Increased Productivity	**Increased pick and place reliability** from 99.5% to 99.98% due to the RTOS ability to harness the faster PC and networks
	50% faster setup time due to the Windows-based platform's ease of use In some cases, product changes can now happen in 2 minutes vs. 20-60 minutes
	10%+ better component placement per hour or component density with each generation of machines without changes to the RTOS architecture
	Ability to double production capacity and board throughout by doubling beam and heads due to the scalability of the RTOS architecture
	Potential to achieve productivity up to 200,000 chips per hour (CPH), the fastest SMT speed on a compact platform

While individual results depend on each company's circumstances, the results listed above have been consistently demonstrated by IntervalZero SMT customers.

CONCLUSION

IntervalZero is the next generation RTOS platform for any machine automation. The primary architecture is designed based on the best practices learned from the SMT industry in Japan and adapted to take advantage of the emerging real-time Ethernet standards like EtherCAT and GigE machine vision. With IntervalZero, customers are already gaining differentiated advantages where it counts: quality, performance, ease of use, time to market and cost.