

Transforming product validation through integrated AI and robotics



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Introduction

Modern-day products are becoming more sophisticated, with higher complexity integration of Mechanical, Electronics, Software, and Online elements, along with AI and GenAI, to deliver simple yet rich user experiences at customers' fingertips at a very fast pace. Traditional validation methods and frameworks, involving manual testing, automation, and statistical sampling, will not be able to scale to ensure quality within the given timeline and budget. Manual testing introduces human variability and scaling limitations. Standard automation often falls short in handling intricate scenarios, while statistical sampling risks overlooking critical edge cases. Most importantly, current methods often fail to capture complex interaction effects between system components.

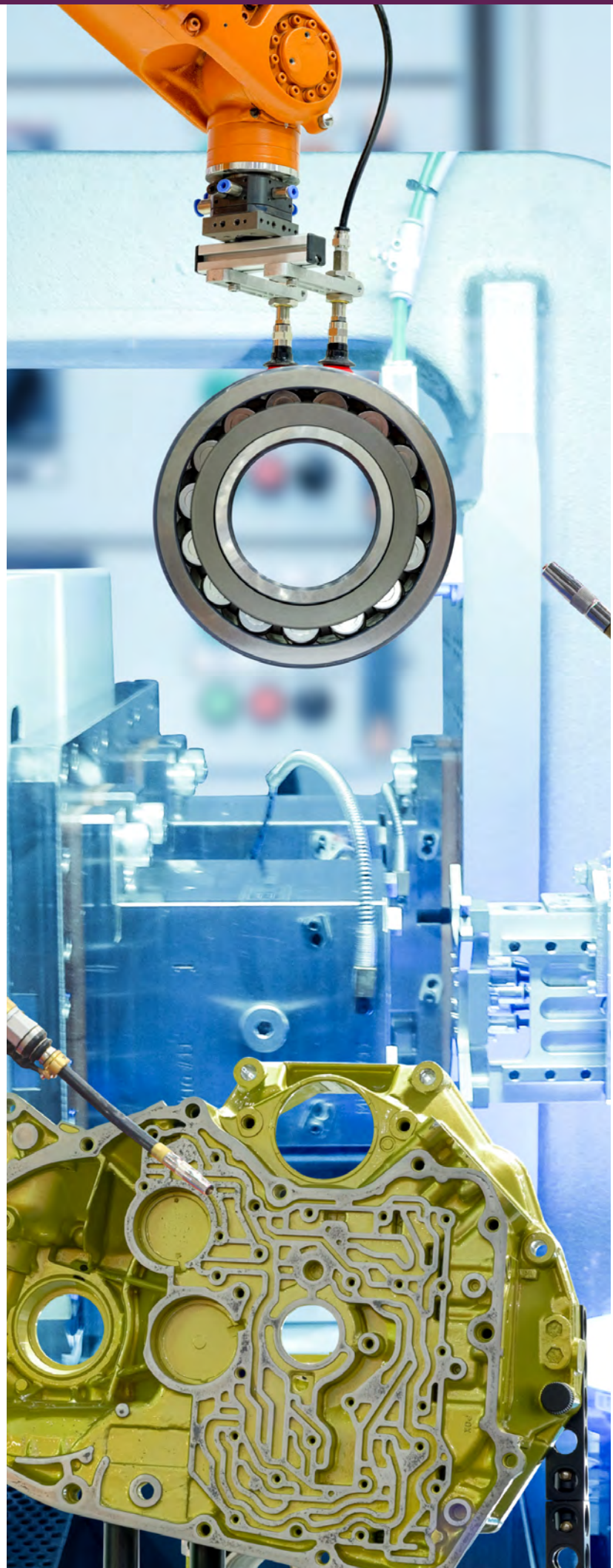
With AI/ML-driven test automation and robotic system, a medical device manufacturer slashed validation time for an insulin pump from six months to eight weeks. This exemplifies the power of innovation, and this success story demonstrates the transformative potential of AI in modern product validation while ensuring stringent quality and regulatory compliance.



Integrated AI-robotics solutions

Integrating AI and Robotics into standard Test and Automation methods can make the automation and standard validation more efficient. This will enable real-time data processing and test adaptation. For example, when validating the device interface, force sensors on robotic end effectors measure button response while computer vision systems track visual indicators. The AI system analyzes this multi-modal feedback, automatically adjusting test parameters to explore performance boundaries.

Intelligent test generation represents another crucial advancement. The system analyzes product specifications, historical data, usage patterns, and updates in hardware or software to identify high-value test scenarios. As an example, for automotive brake controllers, the AI examines safety parameters and known failure modes to generate precise test sequences. Robotic systems execute these tests with exact timing while monitoring multiple sensors, feeding results back to refine future test generation.





Technical foundation and implementation

To successfully implement this system, we need a strong technological base. This includes, but is not limited to, Powerful computing infra including GPUs for training the AI models that drive the robots, and edge systems for real-time control of the robots themselves. High-speed connectivity is crucial to ensure seamless communication between all system components, while robust data management is needed to handle the significant volume and velocity of data involved. The robots themselves must be capable of precise movement, equipped with multiple sensors for accurate perception, and incorporate redundant safety measures to prevent accidents. The selection of appropriate robots, whether off-the-shelf or custom-built, is crucial and will significantly impact the system's overall performance. Since the amount of data to be handled can be high, High-velocity data management is critical. This data includes time-series sensor and test data and logs, automated data pipelines, and robust version control for test configurations.

Validation teams must possess a diverse skillset than just validation and product experience, including expertise in robotics programming, machine learning, and physical testing. System architects with deep experience in real-time control are essential for seamless system integration. It is recommended to adopt a phased approach, starting with pilot programs on well-understood products along with regular audits to measure system effectiveness. This will help to

- Develop and refine AI-driven validation procedures
- Establish robust protocols for investigating anomalies
- Create comprehensive documentation of test coverage



Example of an industry applications

Validation of modern insulin pumps demonstrates these capabilities in action. AI systems analyze pump specifications and performance data, while robotic systems simulate usage patterns. Force sensors monitor insertion resistance as computer vision tracks display behavior. Machine learning models process this multi-sensor data in real-time, identifying delivery accuracy variations before human operators detect them. Similar approaches apply to smart wearables, automotive infotainment systems, and industrial equipment. Each application requires careful consideration of industry-specific requirements, regulatory standards, and unique technical challenges.



Performance measurement and business impact

The transition to AI-robotics validation requires clear performance indicators aligned with technical capabilities and business objectives. Validation teams must establish baseline metrics to measure improvements in test coverage, particularly for edge cases and complex interactions that traditional methods struggle to identify.

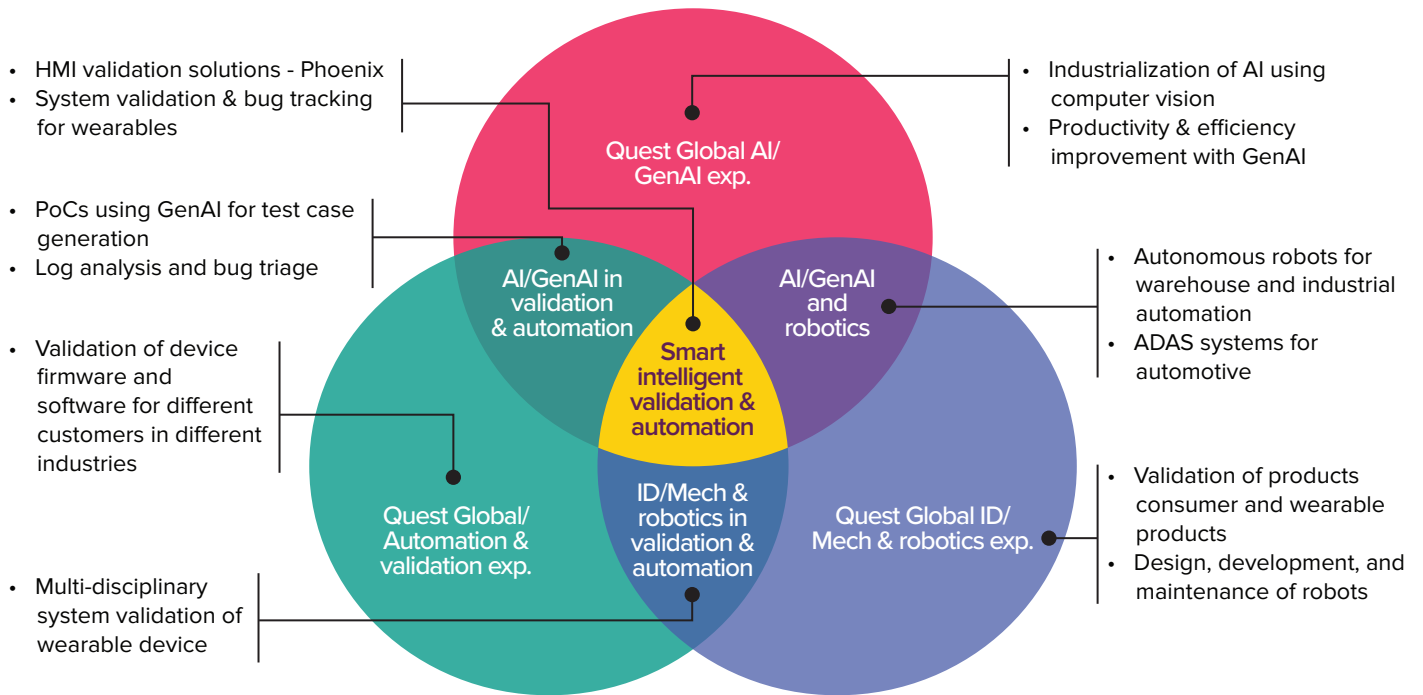
Resource utilization improvements emerge through continuous operation and intelligent test selection. While development cycle acceleration provides immediate gains, long-term value comes from enhanced product quality and reduced field incidents. Organizations should examine validation costs across the entire product lifecycle, including equipment maintenance, team training, and system updates.





The Quest Global difference

Quest Global combines validation expertise with advanced AI capabilities and robotics along with decades of experience across industries. Our teams understand the intricate relationships between mechanical systems, electronic components, and software interfaces that modern validation demands. Our validation engineers develop custom solutions that merge machine-learning models with robotic test systems while maintaining regulatory compliance. This expertise spans medical devices, automotive systems, consumer electronics, and industrial equipment. With validation centers worldwide, we implement consistent methodologies while adapting to local requirements.



Quest Global maintains active research programs in advanced validation technologies, developing new approaches that combine emerging AI capabilities with sophisticated robotics systems. These innovations help clients advance their validation capabilities while maintaining efficiency and quality standards.



For further information or queries, please reach out to us at info@quest-global.com