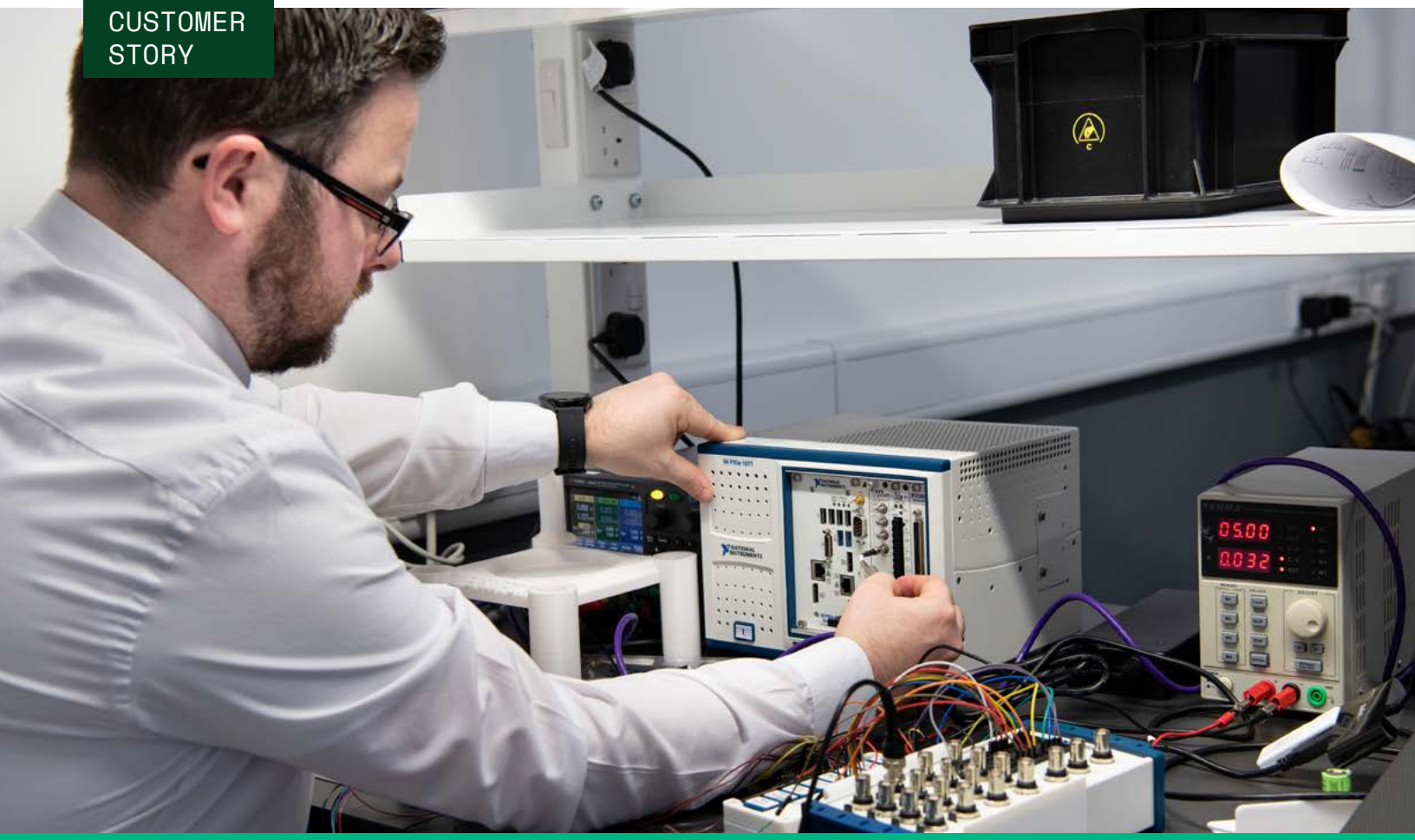
CUSTOMER STORY



Ei Electronics Delivers Business Growth with Test Standardization

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Executive Summary

Challenge

Increased product complexity and manufacturing volumes made the existing test strategy unmanageable and expensive.

Solution

Process, systems, and data standardization across validation and production teams using PXI, LabVIEW, and TestStand.

Success

For validation, a 10X coverage increase and 50 percent time saving. In production, a 17 percent yield increase, 50 percent cycle-time decrease, and maintenance staffing reduction by one-third.

Value

Bringing new smart products to market while maintaining the quality required for life-saving devices that would not have been possible without test standardization.

Company Profile

As one of Ireland's leading electronics companies, Ei Electronics manufactures and exports smart, connected devices that keep families safe in their homes. From smoke and gas detection systems to environmental measurement and analytics, Ei annually ships tens of millions of products to more than 30 countries worldwide and serves the residential sector. An industry-leading reputation for product quality along with established lean manufacturing techniques and a culture for continuous improvement have led to continuous, organic growth for more than four decades.

A privately owned, community-focused company, Ei has shown proven success prioritizing investment in its people over decades of operation. In recent years, significant regulatory and market changes have created an opportunity for growth. To not only take advantage of but lead this market transformation, Ei has instigated a step change in its investment in technology and processes—including test. This strategy of meeting the high market demand for product volume while maintaining a clear differentiation in product quality has led to sustained, exponential growth.

Ei Electronics Expects High Test Value

Quality

Ei's first priority is to ensure quality products from the test department. Because fire and safety alarms are lifesaving equipment, the cost of failure is immeasurable and thus demands reliable operation. Every design is tested with both rigorous simulation and "black box" functional validation. Then, every manufactured product is functionally tested at least twice to ensure reliability once installed. We sell safety-critical devices, and our test processes, systems, and data define our users' trust in our product, so there can be no compromises in test if our business is to be successful.

Functionality

The combination of evolving regulatory standards and R&D innovation to differentiate in new markets means that the functionality of Ei products is continually growing. Over the past few years, alarms have evolved from component-level designs to smart systems, which has drastically changed design and test requirements. Every product has new features such as output signals, humidity sensors, and radio protocols. Our test department claims that they never get "boring work," as every development brings new measurements and challenges.

Schedule

The business cost of being late to market is considerable, as our long-term trust-based relationships with large clients are founded partly on our ability to deliver what we say we will, when we say we will. This includes new product introductions. For this reason, it is imperative that every team delivers on time. Extra pressure is put on test, as any slip in schedule earlier in the process compresses available time for test development.

Volume

Ei manufactures tens of millions of products per year, so process efficiency and speed are paramount. Hitting the production rate on a day-to-day basis is our primary metric on the factory floor. Test engineering addresses this with a combination of parallelism, cycle-time optimization, and downtime minimalization. The channel density we can build into our stations allows us to increase the number of DUTs we can test at once. We compound this with automation, employing operator DUT placement in parallel with functional test. Cycle time is limited by our unwillingness to sacrifice quality; because it can take up to 30 seconds to fully calibrate a smoke sensor safely, we use this time to perform other tests.

Lifecycle

Some fire alarms from as far back as the 1990s are still installed in homes, keeping them safe—in fact, we expect that, within 10 years, Ei will have 200 million active products in market at any one time. This puts immense pressure not only on our design teams to ensure quality for such a long duration, but also on our test teams, who are accountable to troubleshoot any product currently in market to identify root causes behind any reported fault. The average product is in market for around 10 years, so balancing the development of new systems for high-growth, high-volume products with the challenges of maintaining legacy systems for decades is a key pressure for our test team.

Data Insights

We correlate data accuracy with product quality, and therefore, customer safety. But insight into this data can provide far more than product reliability. Visibility into test data across departments can improve validation schedules, manufacturing efficiency, and more. Digital transformation of our production tools is a priority, as it offers improved manufacturing forecasting, allowing us to plan reliably to serve market demands.

Modern Fire and Gas Detection

If your perception of a fire alarm is a white plastic box with a red button in the center and a 9 V battery, you are absolutely correct—you just identified Ei's most popular historical product that has nearly 100 million units currently in market. But you are also 30 years out of date, as this product launched back in '80s!

Modern risk-detection products not only have precisely calibrated sensors, but embedded software, mesh-network communication, and wireless obstruction detection, as well (in some regions, the law dictates that alarms must sense local obstructions, such as furniture, that may impede performance and automatically communicate to system control that the system requires service). To ensure quality of a smart, connected product such as this requires functional test of software, electrical circuits, batteries, wireless radios, sensors, and user interface. What's more, the regulatory rules that ensure customer safety regularly evolve—meaning that each product revision increases the test coverage.

Validation Strategy: Automation

The quality of an Ei product must never be in question. Not only could a failure put lives at risk, but our customers choose Ei products because they know that, once installed, there will be no issues for the full product lifetime. To achieve this, every aspect of the product must be fully verified. The first set of tests we call “white box,” and they’re done in collaboration with the designers. Here, we review every element of code multiple times and test each circuit and component—but this is insufficient. To flush out problems that could be overlooked with a group-think mentality, we perform “black box” testing in which an independent group of engineers are challenged to test every piece of functionality through every situation the product may encounter. Their independence insulates them from potential bias as to how the product is designed. This intense two-stage process differentiates our products from others in the market and is a significant reason why the Ei brand is trusted above others for quality and reliability.

In validation, our first priority is accuracy of our measurements. We need to ensure that we can trust any test result that we record, and so we strive never to compromise. Stage one is to prioritize instrument quality, but stage two is to ensure full control of those instruments with open access to low-level drivers. From desktop PXI instrumentation to large anechoic chambers, we prioritize open architectures that give us detailed insight into how each measurement is taken and allow us to tweak it as needed.

Next, we look to automate as much as possible. Whereas in the past, using traditional benchtop instruments in the lab, we could manage just tens of tests in a day for a given DUT, using PXI we can set up an automated series and run hundreds of tests overnight. This results in both higher test coverage (which we correlate to product quality) and a better use of engineering time. Once configured, automated tests are also reusable, speeding our development process. We have developed a LabVIEW library that covers 40 percent of our validation tests for new products. Automating validation tests with PXI and LabVIEW saved more than 50 percent of time per project compared with our previous strategy. This is time we can use to improve our test coverage and product quality. We like to say that LabVIEW is the only engineer on the team who works three shifts, because when we go home at night, our testing doesn’t stop.

Another way we ensure quality is by considering the validation process holistically rather than as a series of siloed steps. Each prototyped product is assigned a digital passport that contains all test information as well as information on any unusual event that it has experienced. For example, if a PCBA is dropped, or a powerline overloaded, it may look the same, but behave differently in subsequent tests—and tracking these human-caused events in a traceable digital fashion ensures efficient and complete validation.

The standardization of processes, systems, and data across the lab streamlines development, grows test coverage, and ultimately improves product quality.

Cross-Functional Collaboration in Test

As product complexity increases, test coverage requirements increase. Delays at earlier stages compress the production development schedule to meet a static market release date. The goal of collaboration across departments is to ensure standards of product quality while removing risks to the NPI schedule slipping.

All of our engineering is located on the same site in Shannon, Ireland. Design, validation, and production teams work in labs just a few meters from each other, and recent initiatives to promote interaction have paid significant dividends. Historically, tasks were thrown over the wall between departments. This resulted in an estimated 10 percent of relevant aspects discussed in cross-functional meetings due to misunderstandings between departments. By growing a more holistic understanding of the goals and challenges of each function, we now discuss closer to 90 percent of the relevant aspects of test.

Designed-for-test concepts are not new to the industry, but great implementations are rare; it is through the close personal and professional relationships nurtured at Ei that we consider ourselves best in class. Teams share not only product design thoughts, but measurement code, too. We have a single code repository and review code across teams—down to the position of variables within modules to make it straightforward to reuse code. With every passing month, production and validation teams more closely align architectures with the goal that significant code reuse between teams will become commonplace. Our focus on cross-functional collaboration and standardization reduces schedule risk for NPI test projects to a point where 95 percent now release on or before schedule. What's more, the 5 percent we miss are low priority and often placed at the back of the queue by design: Important projects are always delivered on time!

Value does not only flow forwards in the design process from design to production. By providing open access to production test data, R&D engineers commonly pull large data sets relevant to their functionality and use them to identify failure trends. This extra tool helps them home in on a potential product issue before it reaches prototype validation. This is most common in a product's first month of production. Even with heavy automation and repetition, it is hard to find the one-in-a-million error when validating a few prototypes. Once in production, you get to a million products very quickly, and this scale provides data that would be impractical to measure in the lab.

Production Strategy: Standardization

The goal of production test is the quality of the product, as we are the last people to touch it before the customer. Traditionally, we had a different tester for each product; each one built individually and maintained primarily by the engineer who designed it. This became unmanageable over time. Product complexity grew, making tester development schedules longer and less predictable and putting pressure on any individual doing maintenance. Our strategy had to change.

At Ei, we believe that upfront sponsorship of people, process, and technology empowers teams to change, developing engineering careers and providing the highest return to the business, too. One important initiative is building a standardization strategy across design, validation, and production: This is a business and engineering priority. Investment in standardization came through a clear understanding of our test strategy goals, considering returns with a more-than-three-year time frame.

Traditionally, each new product at Ei had a custom design and, consequently, a unique test coverage requirement, but we addressed this with custom test systems that combined a mixture of components (signal conditioning, relays), instruments from multiple vendors, and unique software. Now, we strive for commonality in product design architectures, which solidifies test coverage earlier in the process.

To maximize reuse, standard tests are matched with a set of PXI instrumentation that meets the needs of everything but the most unique corner case requirement. We saw a 50 percent cycle-time reduction with a standardized test platform using PXI, LabVIEW, and TestStand. This cycle-time reduction removes need for double testers within a manufacturing cell, significantly reducing the cost of test and the redundancy of test instruments.

Standardization on a flexible set of modular PXI hardware has also simplified our procurement. We can order hardware in batches, which is easier and quicker and reduces administrative overhead so that test engineers can add the most value. The test components of a manufacturing cell are now so standard that, when product volume increases, it requires minimum effort from the test group to scale our test system replications.

Once we had established a common set of hardware, the next stage was to move this same level of rigor into test software development using Python, C#, and LabVIEW, to name a few. We chose to standardize on just LabVIEW and TestStand software across our systems. Each NPI project starts with what we call the “LabVIEW Kit,” including software architecture, recommended hardware, and go-to resources in our centralized code repository. This not only makes development faster, but more predictable.

Standardization also provides better role specialization. We divide our team with test-sustaining engineers (who are targeted on NPI projects), and test-sustaining engineers (who ensure uptime on the hundreds of testers we have deployed at any one time). Standardized test systems are easier to learn, so development specialists are less often drawn into fixing deployed systems, which keeps them focused. Standard software encourages development engineers across the team to share more code peer review. This improves the quality of code that we output. It also means that more team members can maintain and contribute to each other's project designs as needed, lowering attrition risk.

As engineers, we are always tempted to chase new and exciting technology all at once. At Ei, we realize that successfully evolving a test strategy takes time, training, and teamwork. Change at Ei is always happening—standardization didn't happen overnight. We defined a pipeline of work and made little changes every day. Now, two years in, everyone on the team is onboard—they believe in the reason behind the changes, not just change for the sake of change.

As part of this change, we also elevated the role of test and operations data as a guide in the development of new systems. We used to try to address everything at once, but now, you'll hear engineers around the office asking, "What is the highest failure mode of this component?" We then prioritize, addressing one thing before moving to the next. In this way, we iteratively improve our test processes in a manageable fashion that not only provides measurable business impact, but also does not overwhelm any individual. These changes have a positive impact on team recognition and morale.

This standardization initiative using PXI and LabVIEW reduced the development of new system designs from many months to just a few weeks. NPI development resembles a replication process more than new development, as we have such a significant headstart. The predictable nature of our standardized test development processes has built trust with other functions across the company.

The requirements also have become more standardized: People know how to ask for things, and they know what we can deliver. They understand that a new feature request is not just a green pass flashing on a screen—it represents more people, development, and tools. The entire company better understands this, and more employees respect the role of test engineering. This understanding streamlines the hand-off process and reduces conflict, as everyone understands the development cost of requested features.

The foundation of our digital transformation vision is the product data we can collect through standardized test. We are growing digitalization in manufacturing as we increase the percentage of connected cells. Collecting data from every stage of the process—from molding, through PCBA, and device assembly—gives us the insight we need to accurately forecast production output. Test is critical, as it is the lens through which we can judge our process. Only once we have a unified digital strategy across the business can we really start investing in digital technologies that use this data to add further value. This is a significant area of investment for Ei and represents a huge opportunity for the company.

Measurable Success

Quality

- Maintained industry-leading product quality and reliability
- Grew from 10s to 1000s of validation tests per product
- Gained ability to connect dummy loads (resistance and inductance) to properly test ECUs

Functionality

- Met increasing coverage requirements without significant impact to schedule or cost once again

Schedule

- Automated 40% of validation, lowering project time by 50%
- Reduced production tester development from months to weeks

Volume

- Scaled to 10M+ products per year
- Increased manufacturing yield from 80% to 97%
- Reduced cycle time by 50% with standardized test platform using PXI, LabVIEW, and TestStand

Lifecycle

- Planned to keep products and testers in the market 10+ years
- Reduced maintenance staffing requirement by 1/3
- Significantly decreased staff training required to maintain systems

Data Insight

- Utilized shared test data across validation and production teams
- Gained operational insights from system connectivity to optimize manufacturing efficiency

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