INSTRUMENTAL + Lenovo

Innovation Leader Lenovo Prevents Nearly Half of Production Rework and Gains Approximately \$1 Per-Unit Savings Through Process Innovation Driven by Instrumental



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Introduction

Lenovo is a leading global designer and manufacturer of laptops, tablets, smart devices, servers, and with their acquisition of Motorola Mobility in 2014, phones. Their persistent commitment to innovation and cutting-edge manufacturing processes culminated in the launch of the Motorola Razr, with its folding screen, ambitious zero-gap hinge, display robustness requirements, and miniaturized design. To bring such an ambitious product to market, Lenovo successfully executed on a variety of production process advancements to their already industry-leading manufacturing practice.



Lenovo

When the Motorola Mobility development team handed off Razr to Lenovo's manufacturing team for production, Lenovo partnered closely with Instrumental.

Instrumental's holistic data capturing, intelligent AI processing, and real-time reporting powered the advanced practice of continuous optimization at Lenovo, pushing Lenovo even farther ahead of the competition.

Even amidst the industry-wide business continuity challenges caused by COVID-19, Lenovo has been able to achieve yield improvements, scrap reduction, and team productivity gains throughout ramp and production.

The Challenge

Lenovo has always been a leader in identifying and implementing process improvement, and their approach to the Razr, with its folding display and other novel complexities, was no different.



The Razr's innovative hinge design and folding display introduced novel complexities into the production process.

With the additional communication challenges posed by Covid-19 travel and supply chain interruptions, Lenovo quickly identified the opportunity to innovate by adding Instrumental to their process improvement toolkit to help them go beyond status-quo inspection solutions and tackle several key strategic priorities: rework cost, scrap rate, and total customer return rates.

- To keep rework costs low, Lenovo wanted to explore better methods of discovering issues earlier on the line, before expensive components that could be damaged in rework were added. By doing this, they can reduce both the cost of the rework labor and the scrap rate – the two main cost drivers in rework.
- To further improve their already low customer return rates, Lenovo wanted to prevent regrettable returns caused by unanticipated defects from operator turnover or supplier changes.



Catching a defect downstream means the unit is more difficult and more expensive to rework. To reduce rework and scrap, Lenovo needed a solution that would enable them to proactively intercept defects upstream. Photo credit: JerryRigEverything

The status quo combination of AOI, manual inspection, and functional test stations simply don't offer Lenovo's manufacturing team the data, processing power, or visibility needed to track the shifts in process that cause downstream problems, or serve them well once an issue has surfaced. This causes reactive communication, prioritization, and resolution of these issues – which is too slow for a sophisticated, distributed team spread across three continents.

Motorola Mobility had already deployed Instrumental during development to accelerate product maturity for the Razr. This success drove the Lenovo team to implement this revolutionary level of remote data collection, continuous defect prevention, and virtual collaboration in their production program. This enabled them to identify and act on process improvements quickly – ultimately realizing unprecedented control over quality while simultaneously reducing costs.

The Solution

Implementation

Instrumental supported the Razr program from development through ramp and production, providing seamless, flexible coverage tailored to each lifecycle stage. During development, Instrumental deployed over 10 collection points at key assembly states over just four days. Motorola began using Instrumental's AI to discover unknown defects as soon as images of the first 30 units were collected and ended up with 130 ongoing defect detection, each set up in a matter of clicks.



Lenovo used strategically placed stations in production to ensure defects could be detected and intercepted upstream – ultimately reducing rework and scrap costs.

As the Lenovo operations team was preparing to ramp, they had a head start: the development team had discovered and solved many issues already and had live tests for key trouble spots. This wealth of information enabled the production team to optimize their Instrumental set up, simplifying to 60% of the stations in order to maintain coverage in the most important states of assembly and to address persistent trouble spots.

200+

distinct defects discovered, analyzed, and intercepted with Instrumental

In parallel, Instrumental worked with Lenovo to

integrate Instrumental's results into Lenovo's MES. The integration included enforcing unit routing on the line and pushing Instrumental test results to the MES so that Instrumental's data was incorporated into the overall production metrics.

Identifying and making process improvements

This novel workflow enabled Lenovo to continue to use Instrumental to achieve true continuous improvement by refining quality tests even further during pilot and production, pushing the total monitored defect types over 200. 58 of these tests became live tests: intercepting defective units inline, all while meeting strict requirements for cycle time, operator handling time, and production robustness. Because Instrumental makes it easy, fast, and cost-effective to deploy additional tests, Lenovo was able to intercept and intercept and address much more of their defect Pareto than competitors with more traditional detection processes do.

By identifying units with defects far upstream from functional testing, Lenovo got two benefits: first, they saved on rework costs by repairing units before additional value was added, and second, they were able to avoid doing rework on units that had already had displays installed, which might have resulted in damage to one of the assembly's most expensive components.



Strategically placed Instrumental stations captured images at key assembly states and ran real-time AI tests to intercept defects live on the line. This enabled the team to proactively identify issues earlier and reduce rework and scrap.



Instrumental's real-time interception feature detected missing water detection labels live on the line. If the Razr's water detection label is missing, Lenovo cannot distinguish between abused units and those that should fall under its warranty – driving up costs

Increased productivity

Instrumental's reporting features enabled the Lenovo team to efficiently prioritize critical issues that would most impact quality and drive costs down. The Lenovo operations team highlighted issue prioritization as a core benefit to his own team's daily workflow. The operations team used Instrumental's Pareto and defect rate charts to create priorities, to delegate tasks across the team in the morning, and to check on progress throughout the day. Over time, they were able to watch as issues were eliminated, driving down rework and scrap costs. Through a combination of Instrumental reports and alerts, Instrumental enabled the Lenovo operations team to better focus efforts on what mattered most.



Lenovo used Instrumental's reports to prioritize issues and check resolution status – continuously focusing on what would have the biggest impact.

Lenovo also used Instrumental image data to streamline communication across global teams and solve issues faster. Images captured by Instrumental were used to send updates, explain issues, and rule out possible root causes quickly. Teams separated by continents and language barriers became more productive with Instrumental.



Lenovo used Instrumental images to communicate and solve issues faster, no matter where they were located.

When demand for Razr grew just as the COVID-19 crisis was cresting, Lenovo's forward-thinking optimization approach enabled them to be uniquely agile. They were able to quickly bring up two additional lines and used Instrumental's AI to ensure that these lines ramped quickly and at the same quality.

Instrumental's cloud-based data record formed a key component of their COVID-19 response plan, enabling distant teams to keep moving forward. When the factory opened back up with reduced staffing, Instrumental's defect rate monitoring supported rapid operator training.

Instrumental proved to be an invaluable tool in development and production due to a core differentiator that many vision systems and AI applications lack: data that was easily accessible, delivered at decision-making resolution, to the people who can make an impact. With Instrumental, Lenovo improved team productivity and reduced costs.

The Results

Lenovo's operations team realized both hard return on investment (ROI) as well as process efficiencies from their adoption of Instrumental for their end-to-end product lifecycle, amounting to approximately \$1 of per-unit savings. Hard ROI + Soft ROI saving per unit amounting to approximately

\$1/unit

Hard ROI Savings Summary

- Instrumental intercepted approximately 4% of units for repairable defects, enabling the Lenovo team to repair units that did not meet their quality specification earlier in the process, contributing half of the total per unit savings.
- Using Instrumental, the Lenovo team was able to prevent nearly half of preventable rework in the first several months of ramp.
- The Lenovo team invested significantly in process improvements, leveraging Instrumental data, to drive the average cost of rework down 60% from where it started, saving thousands of dollars.

These factors represent substantial savings for the Lenovo team.

Soft ROI Savings Summary

- Real-time visibility into top issues, so the team can prioritize its work, likely contributing thousands of dollars per month in realized process improvements.
- Faster global team communication enables everyone to stay on the same page, and collaborate remotely, likely contributing several thousands of dollars per month in engineering time savings.

Use Case 1: Increased yield and reduced costs by proactively identifying issues earlier

As the complexity of products in the consumer electronics space has increased, so have defects and rework costs. AOI, human inspection, and functional test stations haven't kept up – they are limited in their ability to detect novel defects upstream and are expensive to implement. The Lenovo team used Instrumental's real-time inspection capabilities to reduce the overall cost of rework and leveraged Instrumental's real-time alerts and analytics to prioritize the best opportunities for yield improvement.

The Lenovo team leveraged Instrumental's AI to detect a missing spacer, a defect that would have been missed by traditional test systems. This spacer prevents electrical shorts between the display's passive components and other parts. Without the spacer, a customer who sits on the phone could cause a short and the front display could permanently fail. The Lenovo team used Instrumental to intercept this defect live on the line, ensuring all units are protected from this failure mode, reducing total customer return rate.



Instrumental's Al intercepts a missing spacer which protects the display from damage during reasonable usage in the field.

In a second example, Instrumental's data was helpful in enabling the Lenovo team to root cause smudges on the inside of the camera window to units where the intended protective liner had fallen off. As a corrective action, the Lenovo team set up a test to identify units upstream without the liner so the smudges didn't occur in the first place, eliminating rework. As a further step, the team set up an Instrumental quality alert so they could know if the failure rate spiked, which happened a few times as new operators were trained. Instrumental's technology enabled the Lenovo team to identify this missing liner as an easy opportunity to improve the manufacturing process, and once implemented with the help of real-time tests and live quality alerts, reduced rework significantly.



By intercepting issues like missing liners upstream, the team prevented smudges that caused rework further down the line.



Instrumental's real-time defect rate charts enabled the Lenovo team to proactively identify shifts in process. The team leveraged Instrumental's alerts to receive immediate notification when the defect rate exceeded the three-sigma limit (indicated as a dashed line above). In this example, the team was able to eliminate the issue, saving a substantial percentage of rework.



Lenovo used Instrumental's flexible AI to detect and intercept gasket issues that were critical to ensuring quality and reducing costs.

As a third example, the Lenovo team used Instrumental's flexible AI to detect issues with the time-of-flight gasket. This gasket is necessary to allow the device to turn off the touch screen when the user holds the phone up near their ear. Due to the Razr's design constraints, the gasket is difficult to assemble and can sometimes fall off during the assembly process. The Lenovo team used Instrumental's algorithms to intercept shifted and missing gaskets. Without Instrumental, the Lenovo team would find these gasket defects at a functional test station for the sensor near the end of the line. Given the design of the Razr, the rework required for units that fail at this functional test is particularly challenging and expensive. Finding defects early, when they are very inexpensive to fix, was a major win.

By placing Instrumental at key states of assembly, the Lenovo team was able to identify opportunities for process improvements that might otherwise have been hidden, and use Instrumental's tests and alerts to realize those improvements and associated savings. Instrumental's technology enabled the Lenovo team to become proactive in improving the process while ensuring every unit that ships to a customer meets their high quality standards.

Lenovo shared that they've increased yield and reduced rework, scrap, and return costs. The Instrumental platform gave their team the tools and visibility they needed to drive these core metrics.



The time-of-flight gasket is quickly covered by other parts of the assembly, making rework after the functional test station difficult and expensive. Photo credit: JerryRigEverything.

Use Case 2: Increased productivity through better prioritization and communication

It's too hard to identify and make process improvements during the chaos of ramp, particularly with a globally distributed team. Before Instrumental, the Lenovo team relied on emailing spreadsheets and build reports, in-person daily meetings, and thousands of miles and weeks of travel to work on the factory floor. While Lenovo had innovated in much of its ramp and production process over the years, ever-increasing complexity and a growing team had become increasingly difficult for teams to manage without an appropriate platform to support this workflow.

With Instrumental, this process became easy because they could:

- Understand the top priority issues with a real-time pareto
- Know immediately when process shifts happen with real-time quality alerts
- Identify the necessary corrective action to take by reviewing retroactive data
- See the impact of corrective actions immediately with real-time defect rates

The Lenovo team used Instrumental to prioritize the most impactful issues and monitor progress towards resolution.

Lenovo's NPI engineering team used the defect rates in Instrumental's daily reports to communicate what the factory team should focus on each day, viewing progress and ensuring issues were resolved and didn't resurface from within the app.



Lenovo used Instrumental reports to prioritize improving processes that would have the biggest impact in reducing rework and scrap costs.

Instrumental data also enabled fast communication and issue resolution across thousands of miles and language barriers. Lenovo used Instrumental to help the Brazil team rule out the factory in China as a potential root cause for an issue in their final assembly process. The ability to quickly search for an issue, and have a visual history, was key to driving communication.

Lenovo mechanical engineers logged in to the Instrumental app every day to check on factory status and prioritize their work. They used Instrumental photos to communicate directly and seamlessly with the factory team.



Defects such as bent springs were caught by Instrumental's algorithms and intercepted in real time



Lenovo's globally distributed teams relied on Instrumental images and data to stay up-to-date with factory operations and quickly communicate updates.

By capturing holistic data, intelligently processing it with AI, and contextually presenting it, the Lenovo team gained the visibility and clarity they needed to make a global team efficient. The combination of reduced travel cost, faster communication, and clearer priorities improved productivity and ensured that the team was focused on the most impactful work.



Conclusion

Improved yield and reduced costs

Lenovo has praised Instrumental for enabling fast and easy process improvements in production. Instrumental enabled the Lenovo team to achieve their production goals by proactively intercepting defective units, providing real-time data for oversight, and sending quality alerts when processes shifted. Lenovo was able to easily improve their production process and realize material cost savings while also bringing multiple design innovations to market.

Faster prioritization, communication, and resolution of issues

Lenovo's team adopted Instrumental to accelerate collaboration across a team that spans three continents. Instead of traveling halfway around the world or trying to explain complex failure analyses via email, the team leveraged Instrumental's traceable data record to bridge the information gap, propelling root cause analysis with virtual analysis. Instrumental's flexible Al was heavily leveraged by the team to discover and track many issues, ensuring Razr customers get the highest quality device possible.

Continuing Partnership

Based on the business case for the Motorola Razr program, Lenovo has continued and expanded its partnership with Instrumental. We look forward to continuing to incorporate smart capabilities into Lenovo's supply chain, enabling their teams to build better products with better processes and improved bottom lines.