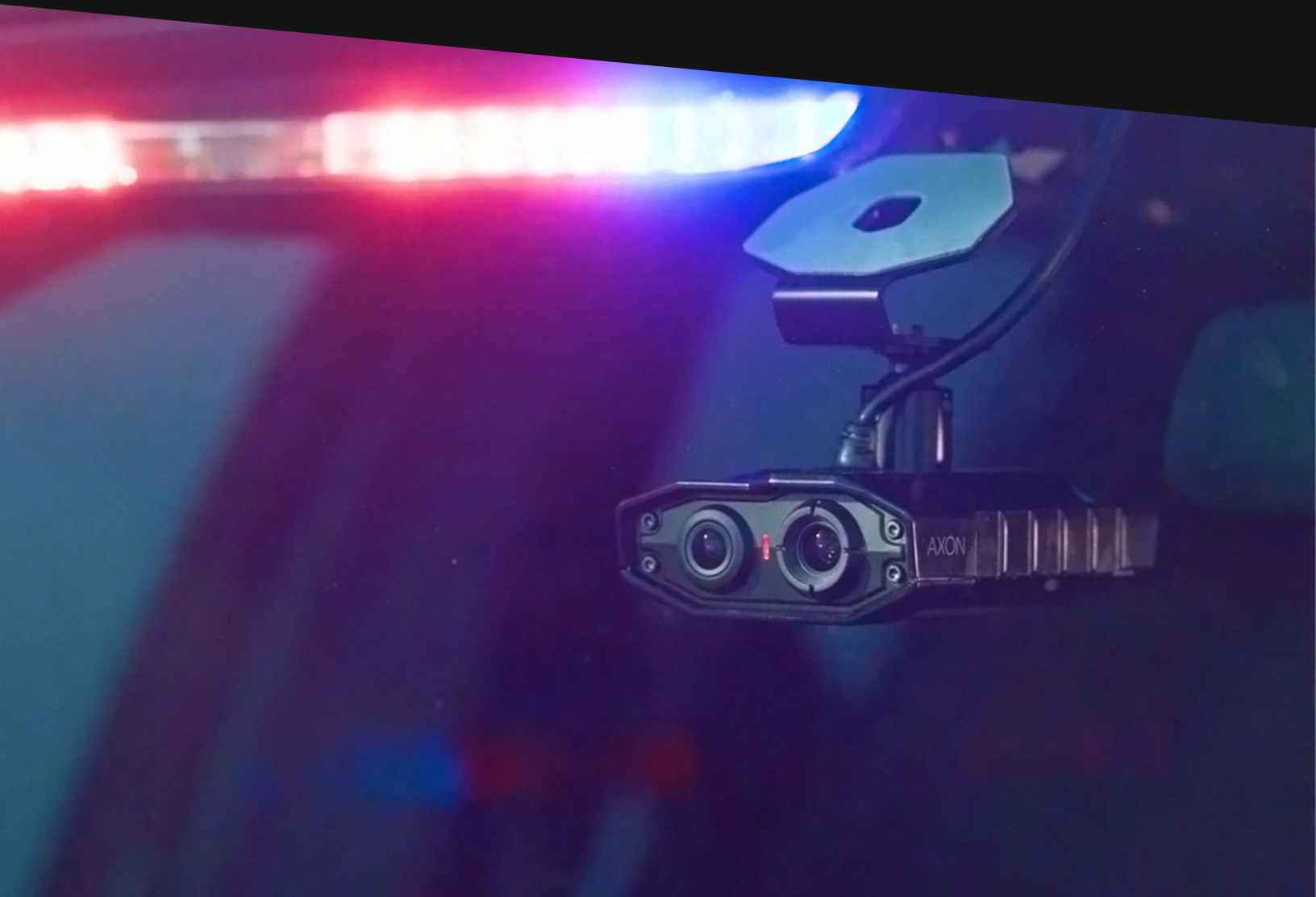# INSTRUMENTAL

# Axon Transforms the Development of Next-Gen In-Car Video Camera

Using Instrumental's AI-powered manufacturing optimization platform, Axon accelerates issue detection and resolution, upgrades quality processes, and gains engineering efficiency from EVT to MP.
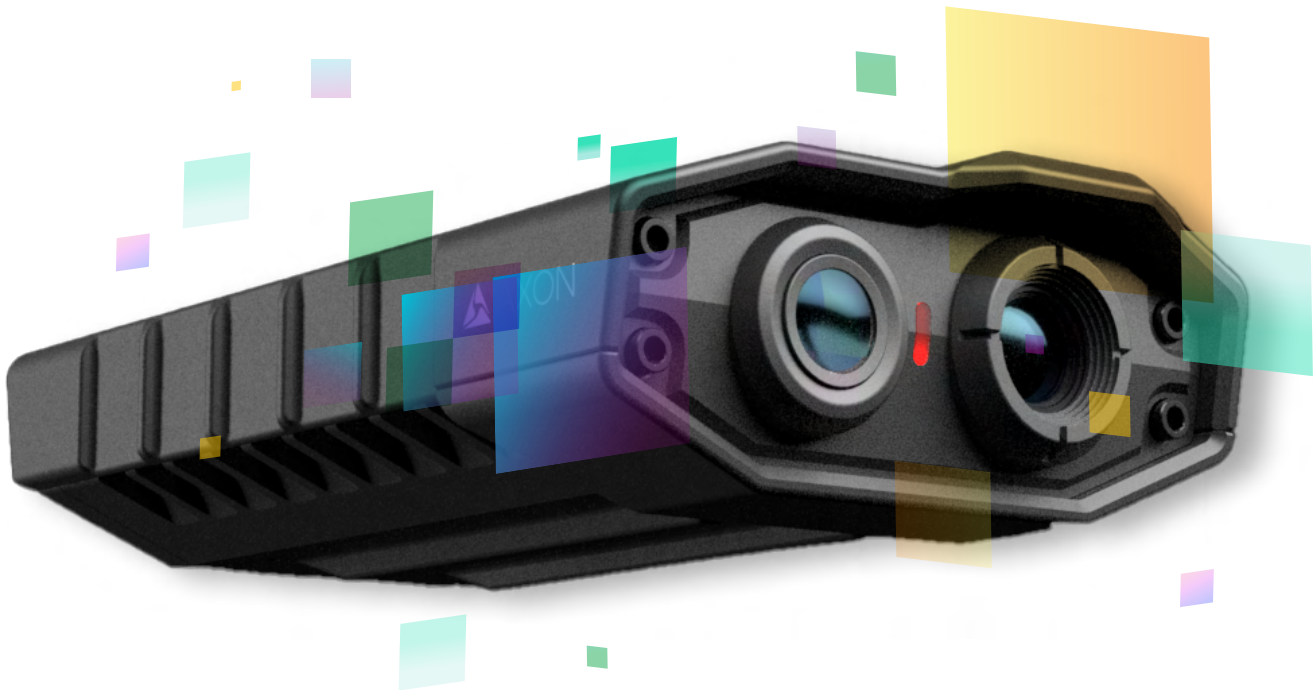
# Contents

# Introduction

Founded in 1993, Axon's mission is to protect life by creating technology and services that promote safety, efficiency, and transparency. They offer a full tech suite of critical devices, software, and training for use by law enforcement, military, corrections, private security personnel, and by private individuals for personal defense. In addition to hardware such as in-camera systems, body-worn cameras, and less-lethal devices like TASERs, Axon has developed technology to handle data to capture, securely store, and manage video/audio evidence. Headquartered in Scottsdale, Arizona, Axon operates and conducts business in over 75 countries with more than 5,000 suppliers worldwide. As Axon continues to grow and conduct business in many countries, its supply chain is becoming more vast and diverse.

**Headquarters**
Scottsdale, AZ

**Offices**
Seattle, WA
Ho Chi Minh City, Vietnam
Tempere, Finland

For Bill Maginn, NPI Engineering leader at Axon, the development and production of hardware has a direct connection to Axon's value of accelerating justice by providing the infrastructure and systems that make the preservation of truth possible. Both the hardware and the resulting recorded evidence are treated as mission-critical assets, impacting front-line officers as well as an array of stakeholders across the judicial system and the community at large.

The widespread benefits of Axon's products and services are immediate. For example, during the early builds of Axon's latest in-car camera system, Fleet 3 (now available), the Automated License Plate Recognition (ALPR) enabled agencies to capture 8 times the plate reads for the cost as traditional systems. Furthermore, Fleet 3 includes mobile ALPR as part of every system, making mobile ALPR capabilities more available to agencies without requiring separate hardware. By accelerating the efficiency of license plate scanning, coupled with mobile ALPR technology, law enforcement can identify stolen vehicles or find people with warrants much more effectively.  For Axon, upholding social justice through product development starts with understanding the impact on the community. Axon established a first-of-its-kind AI Ethics Board to ensure that they operate within ethical guardrails.

# The Challenge

In 2019, Maginn, senior NPI manager Alex Lee, and the Axon team completed the prototype build for Fleet 3 towards the end of 2019. Development of Fleet 3 coincided with bringing up new overseas factories, which meant starting relationships with new contract manufacturers. This situation can be challenging as a high degree of trust in the upcoming build is needed. To compound matters further, travel came to a halt for the team as of January of 2020 due to the spread of COVID-19. This posed further challenges for the team spread across the U.S., Finland, and Vietnam with contract manufacturers located in Taiwan and China.



*Fleet 3*

Additionally, while the NPI team made use of standardized funtional tests for many elements of Fleet 3, not all possible issues are detectable through such tests. It can be impractical to inspect elements like screws or sensitive sealing gaskets in every unit.

For Maginn and Lee, having remote quality oversight at the contract manufacturers in Taiwan and China was essential, especially for a mission-critical product like Fleet 3 that must work reliably in a moving police car, withstanding vibrations, altering temperatures, shocks, and other forces that occur in the course of an officer's daily work. With the global travel restrictions inhibiting the teams traditional on-site support strategy,

> Maginn reached out to Caitlin Kalinowski, Axon board member and Head of Hardware at Oculus.
>
> ## Kalinowski recommended Instrumental to help build out a strategy for remote management of teams and quality.

After researching traditional AOI solutions that require programming, Maginn and Lee found that Instrumental's AI-powered anomaly detection operated akin to a product design engineer, providing insights you would normally get looking over someone's shoulder, inspecting each unit.

# The Solution

## IMPLEMENTATION

As they prepared to ramp up a new factory and enter the EVT build of Fleet 3, the Axon team worked with Instrumental's sales and solutions contacts in the U.S. and customer success representative based in China. Installation of six Instrumental stations, three at a CM in Taiwan and three at a CM in China, only took a matter of two days to set up at each site. Upon the initial collection of images made visible through the Instrumental AI cloud-based app, an unexpected issue became apparent on day one. Instrumental's AI detected an anomaly on the PCB conformal coating, revealing a previously unknown deviation from the design. This insight provided swift proof of the efficacy of Instrumental's Discover AI for automated defect detection at an early stage.



Mask issue with conformal coating on the PCB was detected after one day of implementing Instrumental's Discover AI

With Axon's core team of engineers responsible for the manufacturing process based in Vietnam and unable to travel to the CM in China, Instrumental's customer success lead for Axon, Peng Kuo, delivered invaluable support to build a successful process for remote collaboration. Upon ingesting new image data into the Instrumental platform, Kuo reviewed results of automated defect detection on a daily basis with the ME and TPM teams in Vietnam. The immediate reporting coupled with hands-on implementation help enabled them to quickly determine if anomalies required corrective action and ultimately ensure zero escapes where Instrumental issue monitoring was set up.

> " *It was really helpful to have additional eyes and get help in training the Axon team on using the Instrumental app. Instrumental also conducted post-build reviews with us, which helped us close loops and move forward with the next build."*
>
> **ALEX LEE**
> Senior NPI Program Manager | **Axon**

Furthermore, the use of Instrumental gave Axon a digital record to go back and look at evidence of what was built while helping them proactively discover anomalies to resolve programmatically when travel wasn't an option.

## DESIGN AND PROCESS IMPROVEMENTS

Fleet 3 consisted of two early-stage EVT builds, followed by DVT and PVT builds before mass production with six Instrumental stations set up with dozens of issue monitors installed across CMs in China and Taiwan. Catching and fixing issues early on in EVT would set Axon up for success as they head into their DVT build where production volume increased.

Inspection reports covering the front camera head and interior camera head identified several issues considered high risk, many of which would not have been caught during functional testing. Across three product components in EVT1, the Axon team using Instrumental identified defects at an average rate of 13% of units.

The motherboard assembly required more than 10 different screws, and with manual assembly, missing screws would be common. Through Instrumental, Axon found a high defect rate of missing screws in EVT1. With this data, the Axon team was able to make the decision quickly to implement a robot and then move on to work on other issues.

the Axon team using Instrumental identified defects at an average rate of

# 13%
of units

Axon and Instrumental found more than

# 20
unknown issues

> " *Without Instrumental, we wouldn't have gained the visibility and data to make the case for investment in this process improvement as quickly. We were able to enact a process change using robotics to prevent downstream reliability issues."*

**BILL MAGINN**
Operations Engineering / Manufacturing / NPI Leader | **Axon**



The prevalence of missing screws found led to the implementation of a screw robot to maintain consistency

The team also discovered damage to the PCB, which led to a design improvement on the protective cover fixture to align better with the PCB. By catching issues like these early, the team avoided negative impacts later on.
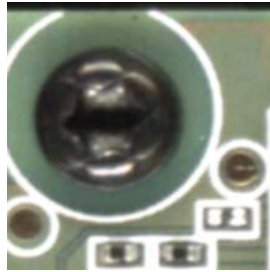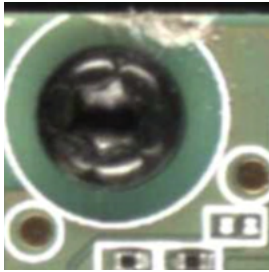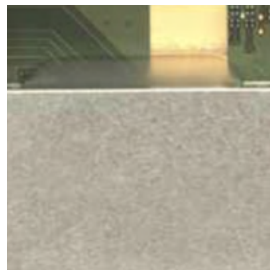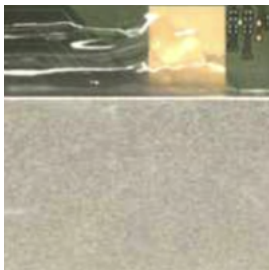


Damage to PCB led to design improvement of the protective cover fixture to align better with the PCB

Additional examples of issues caught and fixed with the aid of Instrumental include:



During the production process, loose screws were intercepted, which was fixed through retraining of operators



Abnormal glue patterns were detected with Instrumental, which were resolved by optimizing dispenser parameters through DOEs
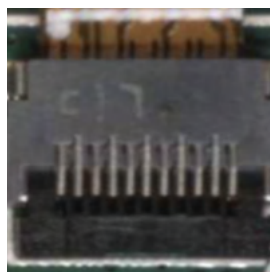


Image on the left shows a misaligned FPC on the camera head, which was caught with Instrumental and fixed by adding an alignment mark to make it easier for operators to align the FPC

After EVT1 and an hour of training with Instrumental, Axon easily set up more than 40 live monitors to catch issues on their own. Compared to traditional AOI and machine vision systems that require months of training, Axon began running Instrumental's proactive AI within two days.

Overall defect rates dropped 6% from EVT1 to DVT. Moving into PVT, the Axon team continued to catch and fix seven previously unknown issues, which included missing screws, fan brackets and misaligned parts such as thermal pads.

Engineering leads, Quang Nguyen and Dat Nguyen, based in Vietnam, representing the most active users of the Instrumental platform from Axon commented, "Instrumental is now an essential tool for our work. It's so much more efficient being able to do virtual teardowns on the cloud to check for issues. We wouldn't have found that many issues early in the NPI stage without Instrumental."

While most machine vision and smart AOI systems focus on the edge, Instrumental proved useful between and after builds helping Maginn and Lee gain visibility into what's happening both at the lab and factories in Asia.

**More than**
**40**
live monitors to catch
issues on their own

**Defect rate reduction**
**from EVT1 –> DVT**
**6%**

Instrumental Assisted
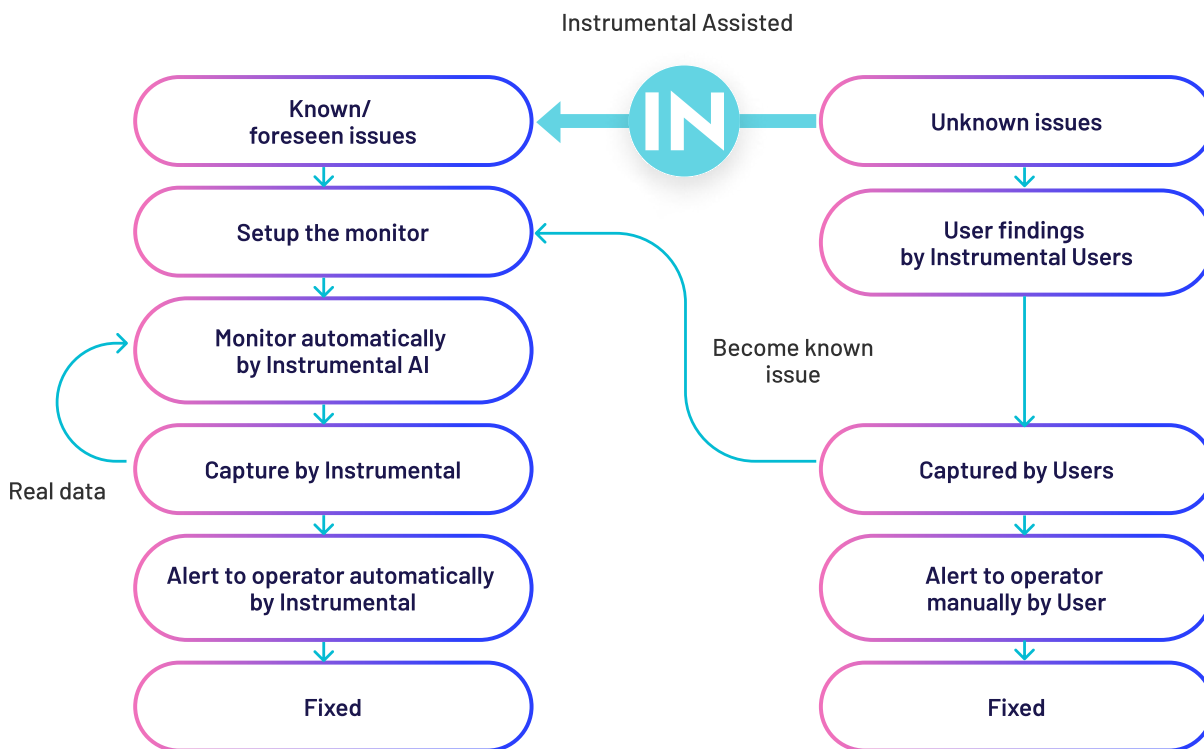
# The Results

The value of using Instrumental could be seen from the early stages through to MP. Results included:

- After the first day, the team automatically detected unknown issues, gained a full data record and instant, remote failure analysis.
- More than 20 different types of unknown issues were discovered, some of which would have resulted in escapes.
- Defect rates dropped 6% from EVT1 to DVT, improving design and processes early on, avoiding rework on dozens of units
- Traceability increased between builds, which enabled teams to rapidly respond with historically accurate information.
- Team efficiency increased. In EVT2, the team saved 35 hours of engineering time by prioritizing efforts on the most important issues.

Introducing Fleet 3 would fundamentally help drive Axon's mission and thus delays weren't an option, regardless of disruptions due to the pandemic and the added challenges of ramping up a new CM. The Axon team stayed on schedule, caught more issues proactively early on, trained staff more effectively without travel, and gained better oversight of remote CM factories.

**20**
types of unknown issues discovered

**6%**
drop in defect rate

**35**
hours saved in EVT2

## LEARNING, MENTORSHIP, AND GLOBAL COLLABORATION – MORE EFFICIENT THAN TRAVELING

As a seasoned professional in his field, Maginn has been through dozens of EVT builds but he recognizes the importance of learning and mentorship for those newer in their career. Daily standup meetings included a review of issues with leads from across the globe. With the support of image data from Instrumental, Maginn and the US team remotely train engineers in Vietnam on what concerns to look out for and work on issue resolution. The teams would investigate how many units were affected. By employing Instrumental for failure analysis using serialized information, Axon teams compare defective units to passing units, gain complete traceability, and recreate disassembly without having to physically tear units down.

## BETTER FACTORY OVERSIGHT

Without a local team, having Instrumental's in-region helped improve communications and visibility into the contract manufacturing lines in Taiwan and China. Clear, centralized data accessible anytime allowed for more productive conversations between Axon and the contract manufacturers. Maginn notes, "By using Instrumental, it was like being at the factories. The transparency Instrumental provided resulted in more prompt attention and a higher level of care for our line, putting us on the same level of priority as other customers with higher volume." After an intensive beta trial deployed to eight domestic and international agencies, the company successfully released Axon Fleet 3 on June 30, 2021.

Although the multi-faceted benefits of using Instrumental made a positive impact on the launch of Fleet 3, Maginn notes that what stood out the most from relations with Instrumental was a fundamental understanding and shared value of Axon's mission.

> *I felt that Instrumental got what we were doing and why our mission is so important to us. Throughout the process, they actively helped us solve immediate problems and they're committed to evolving their platform to further support our needs. We had a great two-way synergy with the Instrumental team and that's why we're getting ready to use Instrumental again on a new product."*

**BILL MAGINN**
Operations Engineering / Manufacturing / NPI Leader | **Axon**
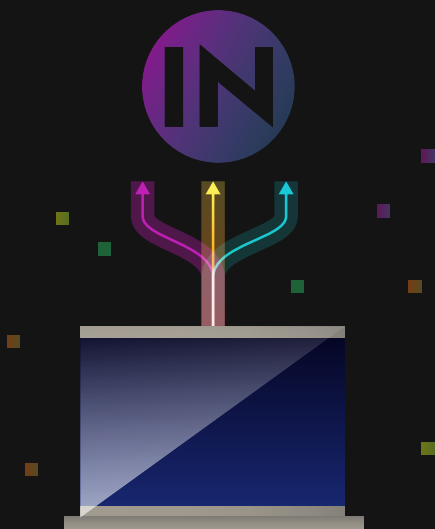
WANT IN?
Want to supercharge your quality, time to ramp, and failure analysis processes too?
Contact us to discuss your use cases and to get a tailored demo of Instrumental.
**sales@instrumental.com**