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Addressing Inspection Challenges in Manufacturing

Inspections: an indispensable tool of modern manufacturing

Whether we like it or not, inspections remain an indispensable tool of modern manufacturing to prevent equipment failures, process deviations, and quality defects. Performed properly, they directly support both top line and bottom line, by helping to maintain the condition and reliability of facilities and equipment, ensuring product quality, reducing the waste of downtime, scrap and rework - even driving continuous improvement.

Robust quality control processes are not just a necessary evil, but essential capabilities to earn and maintain customer trust and customer business, to sustain productive operations, and to remain competitive in the marketplace.

In a perfect world, inspections would be pointless and a pure waste of time and energy. Yet, a perfect world with infallible *men, methods, materials, and machines* does not yet exist. So, trade-offs need to be made between the cost of inspections and the cost of possible breakdowns and defects.

In a typical manufacturing plant, countless inspections of products, processes, equipment and facilities are being performed on a daily basis. Most inspections are planned ahead of time or occur according to some sampling approach or set frequency, while other inspections, such as customer audits, are more ad-hoc in nature (See Figure 1).

Object	Focus
Product	Quality
Process	Productivity
Equipment	Longevity
Facilities	Safety

Inspections

Reason	Frequency
Safeguarding	100%
Compliance	Sampling
Certification	Periodic
Corrective Action	Ad-hoc

Figure 1: Manufacturing inspections

No matter the object, focus, or reason for the inspection, the challenge is to make the inspection processes as efficient as possible, while maintaining maximum effectiveness. But this doesn't always seem to be the case in reality. Inspections are often triggering a slipstream of hidden costs with little added value, while their effectiveness and impact is often questionable. Are the inspection processes and systems truly supporting continuous improvement and operational excellence? Or are they merely a matter of bureaucratic compliance?

Inspection Challenges

Improper inspections can have serious consequences. Equipment may fail. Scrap or rework may increase. Bad quality product may leave the plant, possibly resulting in recalls and claims. Safety concerns may go unnoticed. People can get hurt. Let's review some of the main inspection challenges:

- Like most other processes in modern manufacturing, inspection methods and tools are typically documented in SOPs and standard work instructions. Often, these documents are paper-based, complex, and hard to read. Which can make it difficult for inspectors to fully understand all the exact requirements and expectations. It also makes it a lot more challenging to get new inspectors up to speed and productive quickly.

- A majority of the inspection forms and checklists used on manufacturing floors today are still paper based, resulting in stacks of paper to be filed away or scanned into document formats such as PDF. All of which leads to administrative burden and additional - typically hidden- cost. Very little of it ever results in insightful, actionable data to help drive continuous improvement.

- It is often important to document critical inspection steps with pictures or video, but paper checklists are obviously very limited as to which types of information can be collected. Many companies have introduced tablet-based checklists in recent years, but even those often struggle to flexibly accommodate real-life documentation needs.

- Whether on paper or tablet-based, pencil whipping is hard to avoid, as there is very little visibility into the actual inspection work, due to the lack of step-by-step tracking of the inspection activities. And, with the solutions used in manufacturing today, it is typically pretty challenging to turn any concerns found into easy to communicate and easy to track corrective action items.

- Inspection forms and checklists are often not as complex as for example assembly instructions, so they should in theory be easier to update and maintain. In reality, inspection forms and checklists are often significantly outdated. And they seldomly reflect active quality alerts or engineering change orders. Nor do they dynamically reflect the exact inspection workflow, methods, tools, and specifications required for the specific product version being manufactured - which would be very helpful in today's low-volume high-mix "mass customization" world.

- Inspections should be carried out by properly trained and certified inspectors only. Any non-compliance, or the inability to prove compliance based on detailed documentation, can lead to serious consequences, including recalls and claims. But the existing tools are often unable to enforce proper permissions.

- Finally, customers are starting to expect, and require, full traceability along the complete supply chain. To support the "digital thread", all the way from design to delivery, quality inspection information needs to be digital and a company's QMS needs to be fully integrated with other enterprise systems, such as PLM and ERP. Which makes traditional paper-based systems, or home-grown digital forms, hard to sustain.

Smart Inspections: time for a new pair of glasses

Since the first industrial revolution, pen and paper have been the tools in every inspector's pocket. But digital technologies are finally making these traditional tools obsolete now, reshaping them into antiques of a soon to be forgotten past. Smart sensors, computer vision, artificial intelligence, and digital checklists supported by augmented reality smart glasses are the powerful new instruments for smart inspections in Industry 4.0. These quickly maturing technologies will fundamentally transform the inspection process as we know it.

Smart sensors, computer vision, and artificial intelligence are most applicable to product quality and process parameter inspections. They're game-changing technologies, especially in manufacturing environments where much of the inspection process can be automated. But many companies still have a significant need for manual, operator-driven inspections. For these companies, digital inspection workflows supported by smart glasses can provide step-change improvements, abilities that were out of reach before, and tremendous overall benefits.

Regardless of the specific type of inspection, whether it's about inspecting production quality, process parameters, or the condition of equipment or facilities, it is critical that the inspections are being performed accurately and consistently, using the proper methods and tools each and every time. Inspections should also be carried out reliably, according to the established sampling method or following the prescribed schedule.

Any inspection results should be documented properly for easy analysis and reporting. And, as inspection activities are considered *necessary-non-value-added*, they should obviously be done as efficiently as possible, ideally paperless and hands-free. All of which can be achieved so much more easily now, thanks to the introduction "assisted reality" devices such as Google Glass, Iristick, Vuzix, and RealWear: simple monocular heads up displays, with the ability to show or record values, text, pictures, video and barcodes.

(n=97)

Figure 2: To what extent are smart glasses a good fit for the below use cases?
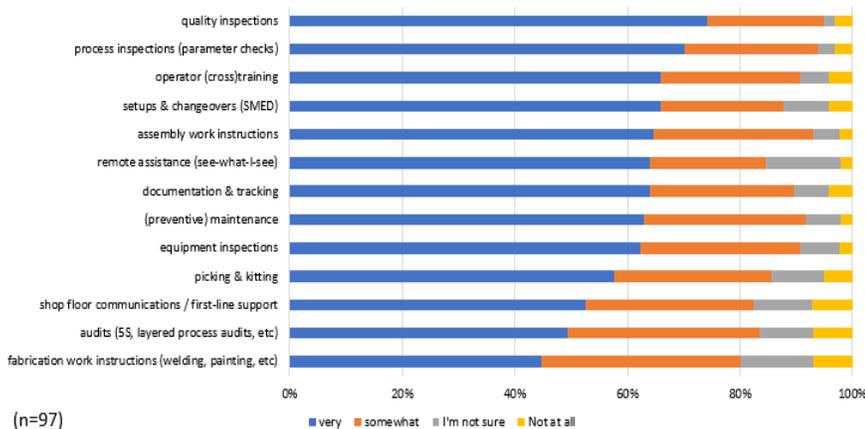
Based on the input to our annual survey, see Smart Glasses on the shop floor – Survey Analysis, a clear majority of the 97 respondents see at least half of the suggested use cases as a very good fit for smart glasses. (see Figure 2).

The two highest scoring use cases can be grouped together in a "smart inspection" category. They include quality inspections and process inspections.

Almost 3 out of 4 respondents (74%) see quality inspections as a good fit for smart glasses. 70% of respondents see process inspections as a good fit. A third type of inspection, equipment inspections, are deemed a good fit by 62% of respondents.

> **Our respondents' feedback matches real-world experience as implementations at early adopter companies have demonstrated that smart glasses can help improve productivity of inspectors by 30% and more.**

Digital execution platform for inspections using smart glasses

Using smart glasses, inspectors can carry out their inspection activities fully paperless and handsfree, making the work much more efficient. They can easily pick the right inspection procedure from a pre-planned to do list or start the correct inspection procedure by simply scanning a QR code. Inspections that are supposed to happen on a set schedule can be triggered automatically with push notifications on the inspector's smart glasses or cell phone.

> **"Using the Proceedix platform, our inspectors are able to follow easy step-by-step instructions, resulting in significant time savings, much improved documentation, and overall better-quality inspections.**
>
> **One of the most powerful features is the ability to quickly and easily document any concerns, and instantly communicate things for corrective action by the proper parties."**
>
> *Kirsten Korte, Senior Project Engineer - Digitalization, Rolls Royce Power Systems*

The smart glasses provide intuitive visual and/or auditory guidance, with easy to understand step-by-step instructions. For complex inspections, or for trainees, pictures and even brief videos can be incorporated to provide extra clarification where needed. Additional information can be made accessible on-demand. And the format and content of an inspection procedure can even be adjusted dynamically based on the skill level of a specific inspector.

Using the smart glasses' touch pad or voice controls, the inspector can capture any readings digitally right away, with immediate feedback on any data entered based on the expected target values and acceptable tolerances. Thanks to the built-in conditional logic, the inspection workflow can even guide an inspector along different routes, depending on the observations and values captured. Using mandatory input capabilities, an inspector can be required to document certain critical inspection steps with for example pictures or video, before being able to proceed to the next inspection step.

The specific inspection workflow can be dynamically adjusted to the precise piece of equipment or product being inspected, by simply scanning a matching QR code, showing the right inspection tools to be used and listing the specific tolerances to be achieved. Any quality alerts, safety notifications, or engineering change orders relevant to the product or equipment being inspected are automatically built in and clearly highlighted, so nothing gets overlooked.

The inspector can easily confirm each completed step by swiping/tapping or by voice control, and all step-by-step inspection activities (*who, what, when, and even where*) are automatically tracked and time stamped. While performing the inspection work, all data inputs are logged and recorded into a central database, for detailed analysis and automated reporting on inspection performance and results, creating a level of transparency that has never available before, and saving significant amounts of time in manual data entry and traditional reporting.

The basic purpose of inspections is to ensure that there are no defects, deviations, or conditions of concern. Or to identify and address any issues before they become a bigger problem. Any time an issue is being identified, it needs to be documented and communicated efficiently and effectively, for proper follow-up and resolution. Using a digital execution platform, such as Proceedix™, inspectors can document any concerns very quickly and thoroughly in mere seconds, including speech-to-text comments, pictures, and video. With a few taps or voice commands, corrective action requests can be sent to the proper parties for follow-up. And, once the issue has been addressed, the maintenance or repair team can document the results and provide immediate feedback to the original inspector -or the inspection team- just as easily. All communications are fully documented and time-stamped, providing all the transparency and accountability needed.

And, in the event that an inspector would need some immediate assistance, he or she can easily get a supervisor or expert involved, using remote assistance capabilities, which establish a live voice and video connection, allowing the remote expert to assess the issue and provide support, based on the inspector's point of view.

Performing inspections according to standard workflows is only possible when those workflows have been pre-defined and made available to the operator, of course. Leading solutions, such as Proceedix™, allow for easy drag-and-drop workflow authoring. Refinements can be made at any time, and any changes made are logged and managed using version control. Updated workflows can be activated and shared with inspectors on the shop floor or in the field with just a few clicks.

In order to make sure that only properly trained and certified inspectors are able to perform specific inspections, inspectors have their own personal login credentials, and only have access to those inspection procedures, or can only inspect certain types of products or equipment, for which they have the proper permissions. As soon as the inspector logs in, all activities are automatically tracked from there. Providing all the documentation needed to support quality control, corrective actions, continuous improvement, and compliance reporting.

Inspection Use Cases

Use Case	Pain Points	Solution Description	Benefits
Quality Inspections	• Inspections or specific inspection steps performed poorly or skipped altogether • Lack of documentation and traceability • Inspections not done by properly trained or certified people • Communication and follow-up on issues • Inspection data not available for analysis to support continuous improvement	• The Proceedix platform allows for the easy creation and management of effective quality inspection procedures • All the right inspection steps, presented in "snackable" format • Hands-free, when using smart glasses • Collecting inspection data in a digital format right away, including pictures and video • Automatic, detailed inspection reports (including *who checked what when how where*) • Communication and follow-up, in case of any issues, thanks to Proceedix action management capabilities	• Increase inspector productivity by 30% • Better quality and compliance by reducing human error, making sure all critical inspection steps are performed accurately • Drive continuous improvement by collecting detailed data for analysis and insight as to what is causing quality issues
Process Inspections	• Manual recording of process parameter values • Administrative burden of paper log and check sheets • Inspections not done according to prescribed sampling or set schedule • Inspections or specific inspection steps performed poorly or skipped altogether	• The Proceedix platform allows for the digital recording of values, text, QR codes, pictures, video, etc. • Inspection requests can be sent to inspectors based on specified triggers • Step by step digital work instructions specify the right tools and measurements at each step	• Values captured digitally are available automatically for analysis • Guarantee that the inspection is done at the set schedule • Reduce the risk for mistakes during the inspection process
Equipment Inspections	• Equipment breakdowns having major consequences • Inspection procedures are typically complex • Inspection procedures not equipment-specific enough • Detailed guidance not easily accessible	• The Proceedix platform allows for the creation of specific and detailed equipment inspection procedures • Remote eye® technical assistance enables live and hands-free collaboration between remote experts and local inspectors to get issues resolved quicker and better	• Improved availability and longevity of equipment • Reduced travel time and cost for in-person visits by remote experts

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Return on Investment

Once in a while it is worth considering the administrative burden of inspection processes. How much time is spent on creating, sharing, and archiving inspection reports? How much time do people spend each day on re-entering paper records into Excel, and transforming them into graphs for management reports and presentations? How much time is lost in searching for the exact historical data when running an audit? How much effort is involved in documenting, communicating, and tracking non-conformities detected during inspection?

The effectiveness of many inspection processes is not always clear either. How many operators are ticking boxes, just to seem compliant? Who is truly verifying the control records and taking swift action for remediation and improvement? How many detailed inspection sheets, possibly containing very valuable information, are buried in folders and dumped into archives, never to be viewed again?

It does not require a vivid imagination to see the advantages of mobile and wearable digital technologies for the lean and effective execution of inspection processes. The proper execution platform, implemented well, makes it possible to significantly improve the quality and speed of the inspection work, while shortening reaction times for solving any issues. Its digital nature eliminates most, if not all, of the non-value-adding paper administration. Of course, these benefits need to outweigh the cost of hardware, software and implementation, including possible integration into the company's information backbone.

The most obvious cost saving is typically related to inspector productivity. As stated earlier in this solution brief, implementations at early adopter companies have demonstrated productivity improvements of 30% and more, which by itself is typically more than enough to justify the investment.

Even more important actually, but often a bit harder to quantify, are the cost savings achieved thanks to the improved quality of inspections, such as avoiding equipment downtime, reducing the wasteful further processing of defective work-in-progress, and preventing that bad quality product leaves the plant and reaches the customer. These savings are very dependent on the company's specific environment and cost-of-poor-quality assumptions, but -with some effort- can be quantified pretty well.

Many further cost savings are more difficult to quantify, including the value of improved safety, improved documentation, better traceability, prolonged asset life, and accelerated continuous improvement. Taken together, the potential benefits to be achieved through the implementation of digital inspections using smart glasses are typically very significant, and more than sufficient to achieve a very positive five-year ROI and NPV.

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*A company with $50m in sales revenue can save up to **$300k** annually by using smart glasses for quality inspections, with a payback period of less than **6 months**.*

Beyond Inspections

Inspection activities are primarily focused on after-the-fact quality control. Preventing issues in the first place, through for example effective maintenance and quality assurance processes, remains critically important, of course. The good news is that effective tools for quality inspections, such as the Proceedix™ digital execution platform for work instructions and inspections, are just as effective in supporting preventive maintenance, fast and accurate equipment setup, defect-free assembly operations, and much more.

Clearly, the smart glasses that have become available in recent times, starting with Google Glass "Enterprise Edition" just a few short years ago, offer tremendous benefits to support effective and efficient inspection operations. But, with the proper software platform, regular smart phones and tablets can provide many of the same benefits, except for hands-free operation. The right software platform, such as Proceedix™ supports both mobile and wearable devices, allowing companies to *mix and match* whichever hardware makes sense for them.

About Gemba Systems Inc.

Gemba Systems Inc. helps companies navigate the complex and fast-evolving landscape of Smart Manufacturing and the Industrial Internet of Things. We offer guidance, tools, and hands-on support in the selection and implementation of those industry 4.0 technologies that will best support our clients' most critical business processes, and the people who perform them. We are especially excited about the step-change benefits of informed and augmented reality solutions on smart glasses, and support companies with use case assessment, proof-of-concept, pilot implementation, and enterprise-wide deployment.

For more information, please visit www.gemba.systems or
to receive your own use case ROI, contact us at alain@gemba.systems.

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