GUIDE

HOW TO SOLVE PRODUCTIVITY ISSUES WITH AUTOMATED QUALITY CONTROL

A recent study [1] shed light on the main sources of productivity issues in quality control. A total of 172 respondents, mainly quality engineers (39%) with various experience levels—0-5 years (34%), 5-10 years (27%), 10-15 years (15%), and 15+ years (24%)—answered a series of questions regarding their quality control process.

51% of the people surveyed identified part complexity (geometries and surface finishes) as their main productivity issue, while 24% identified measuring speed and another 24% identified labor expertise.

In a context in which parts are becoming more complex, skilled resources are harder to find, and measuring equipment is both difficult to access and slow to operate, how can quality control overcome these productivity issues and produce more parts of the highest quality in less time?

This guide aims to present solutions, in the form of best practices, that will help quality engineers and managers solve their productivity issues and guide them through the implementation of an automated dimensional inspection solution for their at line and inline metrology applications.

1. The study included 8 multiple-choice questions and was conducted between April 15 and June 15, 2018 on the website creaform3d.com from site users, customers and non-customers.

COMPLEXITY

In quality control (QC), complexity applies to the measurement of various shapes, sizes, and finishes, which are becoming increasingly common in the manufacturing industry. Complexity is also reflected in the programming time, because the control of sophisticated 3D shapes is possible only if the entire surface is measured. Controlling all the data representing a complex geometry requires programming time. These difficulties, which have a negative impact on productivity, must be addressed.

COMPLEX SHAPES AND SURFACE FINISHES

How to choose the best technology for measuring complex shapes and surface finishes?

Choosing a technology that is highly flexible—i.e., capable of measuring any surface material or finish without preparation—is the key to inspecting parts directly out of the manufacturing process.

METROLOGY-GRADE 3D SCANNERS
Metrology-grade 3D scanners are flexible instruments capable of measuring different complex shapes and surface finishes without preparation and in different contexts.

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Flexibility
One of the best ways to validate the performance of a measuring tool is to test it with various complex shapes and surface finishes at different stages of the manufacturing process, such as before and after machining or before and after painting. Another way to test an instrument is to inspect a part sampling that represents 80% of the produced parts. Moreover, parts that present challenges and complex geometries should be tested. The key is having a measuring instrument that is capable of navigating the different degrees of complexity.

Context
Context is another important element to consider when validating the performance of a measuring tool. QC managers need to identify in which context—inline inspection, routing inspection, “first of” and “last of” inspections, urgency, or development phases—the device will be used and validate how it performs in this specific context. It is worth noting that an instrument may perform well in a specific context, but if that context rarely occurs, the inspecting tool will have no value for the organization.

BENEFITS

Testing a measuring tool on a multitude of complex shapes and surface finishes at different steps of the manufacturing process confirms that it can be reliable whatever the context. Thus, in an urgent situation, the QC manager can be confident that he or she can handle the situation.

PROGRAMMING TIME

How to minimize programming time?

Product integration, from the hardware device and the software connectivity to the final inspection results, is the key to handling complex and painful programming time. Indeed, it is easier to be productive and more efficient when all of the tools operate under the same architecture. Learning new software takes time, and working with different interfaces requires greater focus. Therefore, saving on programming time is valuable when facing productivity issues.

NEW GENERATION OF 3D SCANNING CMMS
Traditional automated coordinate measuring machines (CMMs) involve tactile probes working in a controlled environment. The technology, which is slow to operate and more adapted to metrology labs, doesn't help in solving productivity issues. However, a new generation of 3D scanning CMM, which is mounted on a robot and offers the same range of accuracy as traditional CMMs, is the key to solving productivity problems. Industrial robots equipped with a 3D scanner are accurate, fast and suitable to shop floor measurements.

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When testing new equipment, look for the complete solution. The software platform is as important as the hardware material. Each step, from unboxing the tool and starting the computer to saving the final inspection report, is relevant. Another important point to validate when choosing an inspection solution is the capability of working remotely or off-line in a virtual environment (also called a digital twin). Thus, make sure that this virtual environment is a fair and accurate representation of reality. Again, ask questions during the demonstration of the process to confirm that all of the required tools are included with the complete solution.

A well-integrated product should have capabilities and functions that enhance the behavior of the measuring instrument. For instance, operators should be able to use different scanning techniques to optimize the performance of a 3D scanner, such as scanning perpendicularly to reduce the noise on the boundaries, using photogrammetry to maximize the volumetric accuracy, and adapting the scanning speed and resolution to decrease the scanning or processing time.

There are several generic solutions available on the market that can help to reduce programming time, but the most powerful products always consider the complete ecosystem, such as the measuring methods and the hardware functionalities. Therefore, an integrated programming solution must generate, automatically or interactively, the right scanning experience to benefit all users and not just experts. This way, it is almost impossible to perform a poor acquisition.

BENEFITS

Buying a complete solution, with integrated hardware and software, helps to reduce the programming burden. Reliable and accurate digital twin environments, which are a virtual representation of the measuring machine, can be a powerful tool to overcome complexity issues, such as programming time. Not only can the virtual environment be used for simulation, but also for preparation. Indeed, the more users can prepare and validate a behavior in the virtual environment, the less work will be left to complete when running the program on the robot for the first time. Even though certain phenomena, such as material shininess and reflectivity, are impossible to simulate in a virtual environment, it is recommended to prepare the program and adjust the laser parameters, such as speed, shutter time, and scan resolution, in the digital twin first.

A digital twin solution that is well integrated can be filled with functions specifically developed for the device. With dedicated functions, programming can become easier and faster. The latest generation of integrated hardware/software solutions can generate optimized robot paths for specific 3D scanners, interactively or automatically, in a user-friendly interface, which is helpful in multiple applications, including working with complex 3D shapes. In short, integrated solutions contribute to making the technology more accessible to non-robotic experts by solving programming issues and helping them feel more secure in the presence of robots.

SPEED

Speed is another factor that can lead to productivity issues by causing delays on the production lines, creating bottlenecks or simply slowing down time-to-market and deliveries to customers. The causes of this lack of speed can be internal (such as non-compliance and rework), external (such as customer complaints), or related to the measuring time of the inspection tools. These challenges, which have a negative impact on productivity, must be addressed.

INTERNAL AND EXTERNAL PROBLEMS

How to avoid non-compliance, rework, and lack of customer satisfaction while accelerating measuring time?

To address internal problems, consider incorporating quality control into the manufacturing process. Opting for automated inspection solutions for at line or inline metrology applications also helps when dealing with external issues.

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Integrating quality controls at different stages depends on the manufacturing process. The first step is to start with the part that you want to measure. Look for deformation and where it could come from. Based on the type of deformation, start at the beginning of production (for sheet metal stamping and casting*) or at the previous stations (for composite part trims**), and investigate each operation. What could have caused the observed deformations? Apply adjustments and remeasure the part. Performing more measurements requires time, but in the end, it contributes to improving part quality, thereby reducing internal and external problems.

* *If the shape is wrong, it means that the die or mold is probably wrong. Apply the observed deviations (whether complete or a fraction) to the tooling, and produce a new part. Once the quality is good, measure the part after every manufacturing step. This process will serve as a new nominal target for production.*

** *If the measured trim points have a large deviation, it means that the trimming fixture is faulty. Correct the cutting fixture at the station or adjust the robot program.*

BENEFITS

Product development teams can reach the "start of production" stage quicker and help in early problem detection. Solving internal problems also helps with external problems, as there are generally fewer customer complaints. In addition, reverse engineering a manufacturing process that produces good parts has several benefits. First, it compensates for a large number of phenomena that are difficult to predict, such as strain and spring back. Second, it enables good parts, with the right shapes, dimensions, and sizes, to be obtained and assembled correctly at the end of production.

MEASURING TIME

How to accelerate measuring time?

Measuring speed can be addressed with 3D scanning technologies. 3D scanners that offer the best scanning experience combine high measuring points per second with a large field of view. When searching for a solution, look for a 3D scanner that acquires data quickly without compromising on data quality.

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Production pace
Choosing the right 3D scanning solution depends on the type of applications required. In cases where users want to measure parts directly inline, instruments capable of performing millions of measurements per second should be prioritized. For example, the typical cycle time in the automotive industry varies from 40 to 50 seconds. During this time, users must perform the part loading, measurement, analysis, and unloading. The best technology for this type of application is an array of 2D or 3D profilers (typically between 4 and 8). The part comes in, all cameras take snapshots, and the part comes out. The acquisition process only takes a few seconds. The analysis time is usually very fast as well. Therefore, such a solution enables users to keep up with the pace of production.

Vibrations and Temperature Variations
However, there are some limitations. Vibrations and temperature variations can drastically impact the volumetric accuracy—i.e., the combination of the local accuracy of a 3D scanner and the accuracy of the position of each sensor. This type of solution is based on the assumption that all of the cameras are static. The accuracy of the camera registration (position and distance between each camera) needs to be added to the accuracy of each sensor. If the link between cameras changes, then the system cannot compensate for it. Therefore, users will be under the impression that the parts are faulty or that something else is impacting the manufacturing process. It is like being in a vehicle and not knowing that it's moving. One could think everything else around the vehicle is in motion. Users usually invest a lot of money in rigid fixtures to avoid such problems. However, those fixtures are expensive, dedicated, and not flexible. To avoid this situation, an external tracking device should be used. Optical technologies can track an object dynamically in real time and compensate for floor vibrations or fixture changes due to temperature variations.

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Shop Floor Ready Solution

When looking for an inline solution, going to the metrology lab is not the only option. Although shop floor CMMs have been available for a while, new 3D scanning CMMs, which are more suitable to shop floor conditions, have been released in recent years. Almost all metrology system providers now offer devices that can be mounted on industrial robots. These automated quality control solutions provide users with maximum reliability because 3D scanning is a perfect application for industrial robots. Indeed, this type of robot was originally designed to serve in “low mix-high volume” production. They were built to work at a higher speed and carry higher payloads than any metrology system. In the end, having a shop floor ready 3D scanning CMM next to the production line can save measuring time, because 3D scanners are fast, and operators do not lose time carrying parts to the quality control lab, as the setup is located next to the production line.

The key to being successful with automated measuring solutions is to simplify the deployment. Turnkey solutions can contribute to saving a lot of time in design and integration of a robotic cell.

BENEFITS

Whether you work inline or at line, 3D scanners are faster than traditional measuring machines, which helps users save measuring time. Because measurements are performed on the production floor, operators do not have to move the parts to the quality control lab. Therefore, time spent transporting parts is saved, and inspection results are obtained without delay.

By comparing a turnkey 3D scanning CMM (made of a robot and a scanner) with a traditional machine (made of a CMM and a touch probe), it is clear that the first increases productivity while enabling a similar range of accuracy and volumetric precision. Quality control managers, who are non-experts in robotics, will be able to use a turnkey solution to optimize the repetitive tasks for which human contribution does not offer added value. Thus, they can relocate their human resources to more important tasks.

LABOR

The lack of skilled human resources is the third factor that can lead to productivity issues. Manufacturing companies now have to operate with a lack of manpower and limited working time, which negatively impacts productivity. Let's see how we can address this issue.

EXPERTISE

What is the best way to operate with a lack of man-power and limited working time?

Automated quality control solutions help with the lack of qualified technicians by taking over non value-added tasks, such as moving a scanner over a part. Using human resources on value-added tasks can motivate employees while creating value for the organization. When value is created, employees are no longer assigned to humdrum tasks, which supports retention.[2]

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Design, Integration, Operation
The deployment of an automated quality control solution is divided into three steps: design, integration, and operation. During the design step, users usually build the plan, the layout, and the list of materials required to build the robotic cell. The integration phase consists of installing and programming all of a robot's trajectories. The operation phase is when the machine is put into operation. Optimization also happens during this period. Not only does the operation phase create value, but also every step of the deployment can generate worth for the organization. The main limitation of deployment is the cost of integration. Therefore, other factors, such as the lack of standards in robotics—different brands, different programming languages, and different methodologies—and the lack of skilled employees with experience in robotics, must be analyzed to limit these costs.[3]

How to address the lack of standards and skilled employees with experience?

Option 1: Collaborative Robots
The new generation of collaborative robots directly address these two deficiencies. The ease of installation, electrical connection, and programming make collaborative robots very attractive to anyone willing to take over their first robotic project.
Their collaborative aspect is also interesting because it eliminates the need for a safety mechanism, even though 80% of collaborative robot projects work with safety guards. Therefore, even if a collaborative robot is used, a risk assessment analysis must be completed. At all times, humans must be protected when the robot performs a dangerous task.

Option 2: System Integrator
Another approach is to work with a system integrator who can deliver end-to-end solutions. Since every integration project has overhead costs, some system integrators may be reluctant to take on smaller projects. Therefore, when working with an integrator, plan to invest some of your time in the project. As mentioned above, the cost of integration can increase very quickly if not realize in-house. Some examples found in the literature suggest that for $80,000 of robot and equipment, integration costs are around $170,000.[4]

Option 3: Turnkey Solution
A turnkey solution is the third option. A fully pre-engineered measuring cell creates value during the design and integration phases because the design has already been proven. The organization will then move to the operation phase more quickly, leading to a better return on investment (ROI). Plenty of automated quality control solutions are available on the market.

2-3-4 As described in "Lean Robotics" book written by Samuel Bouchard, Founder and CEO of Robotiq. https://leanrobotics.org/

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Communication
Regardless of which option is chosen, it is important for management to communicate their reasons for automating a certain task. Employees may sometimes feel threatened or insecure regarding their future in the organization. Therefore, it is important to remain focused on the human factor. A communication plan will engage and involve people in the robotic project.

BENEFITS

Once the deployment is successful, people will have more time to focus on value-added tasks, which will free up even more of their time. Thus, they will no longer feel like there are not enough hours in a day.

CONCLUSION

Part complexity remains the main productivity issue in quality control. This problem can be solved with flexibility. A flexible solution, such as a metrology-grade 3D scanner, is an instrument capable of measuring a variety of complex shapes and surface finishes without preparation. It can also be used in different contexts, such as during inline inspection, routing inspection, “first of” and “last of” inspections, urgency, or development phases. Moreover, flexible solutions are generally very fast and easy to use. Therefore, a flexible solution solves the complexity issue, as well as the speed and labor issues noted in the study.

Before considering the deployment of an automated solution, it is important to reflect on the type of integration project. The type of production (low mix-high volume versus high mix-low volume), the available budget, and the internal experience in automation must be considered. Whether dealing with a system integrator or opting for a turnkey solution, a supervision and communication plan is necessary. Above all, we must take into account the human perception of robots. People who will see their tasks replaced by a robotic machine must be involved in the process, understand their new tasks, and see their new value added in the organization. In short, this transition to automation must be done thoughtfully and with respect.