



## **-How to Calculate, Document and Share Process Knowledge**

In today's manufacturing environment, it's difficult to meet production and quality expectations with machine operators having various skill levels. Experienced operators know how to react to part measurement information to make process corrections. However, less experienced operators struggle with this task. This leads to confusion, inconsistent quality and production loss. The problem is magnified as the complexity of the manufacturing process increases. To resolve this dilemma, engineering must spend excessive time training the machine operators and supporting the manufacturing floor.

Organizations need a system that guarantees a consistent method for analyzing measurement data and distributing machine adjustment information throughout the organization. This need is even being recognized by industry leaders such as the SAE International organization. They addressed this issue by adding a new section called "Organizational Knowledge" in the AS9100 Rev. D Aerospace Standard. The standard addresses the need to determine and manage the knowledge maintained by the organization, to ensure the operation of its processes and that it can achieve conformity of products and services.

This paper describes how one company resolved the process adjustment issue.

### **Company**

Kemlab Production Components, a division of Kemco Aerospace Manufacturing is an advanced contract manufacturing company. With multiple redundant machining centers across three divisions, Kemco Aerospace is among the largest independent aerospace machining shops in the United States. They specialize in many aspects of aerospace manufacturing, including contract manufacturing, high volume machining, quick-turn, spares, complex assembly and prototyping.

### **Problem**

The company produces parts used in modern sporting rifles. The production volume for these parts is high enough to support multiple machining cells with several operators. The parts contain numerous machined surfaces that require multiple tools in the production process. Since the production process is complex, the area supervisors' struggle interpreting the inspection results to make machine corrections. The CMM inspection reports are too long (over one hundred dimensions) and the manufacturing process is complex. This leads to lost production time, inconsistent process correction techniques and invalid machine adjustments. Additional hours are consumed by engineering and management supporting production.

### **Solution**

Implementing the Reaction Plan Manager++ software solution for the firearm components manufacturing process provides a tool for the area supervisors to get specific instructions to adjust the process in real-time. The software analyzes the part measurement results and displays the instructions automatically. The supervisors simply follow the directions. It's like having an engineer on the floor 24 hours a day 7 days a week.



## How it Works

Engineers at Kemlab Production Components configured the software by developing Reaction Plans for the manufacturing process for each firearm component. Reaction Plans handle the data analysis and contain the instructions the operator sees for a process. Once released to production, the software monitors the measurement system waiting for new part measurement data. When new data is available, the Reaction Plan for that process automatically loads and executes displaying the adjustment instructions.

Kemlab Production Components use Ziess CMMs to measure their parts. The CMM's are located in rooms away from the manufacturing area. The Reaction Plan Manager++ and QC-CALC Real-Time software packages are installed on the CMMs. QC-CALC Real-Time is statistics software that collects the part measurement data from the CMM and transfers it to Reaction Plan Manager++ for process analysis. The operator simply measures parts on the CMM. The measurement data is automatically collected, analyzed and reported (Figure 1).

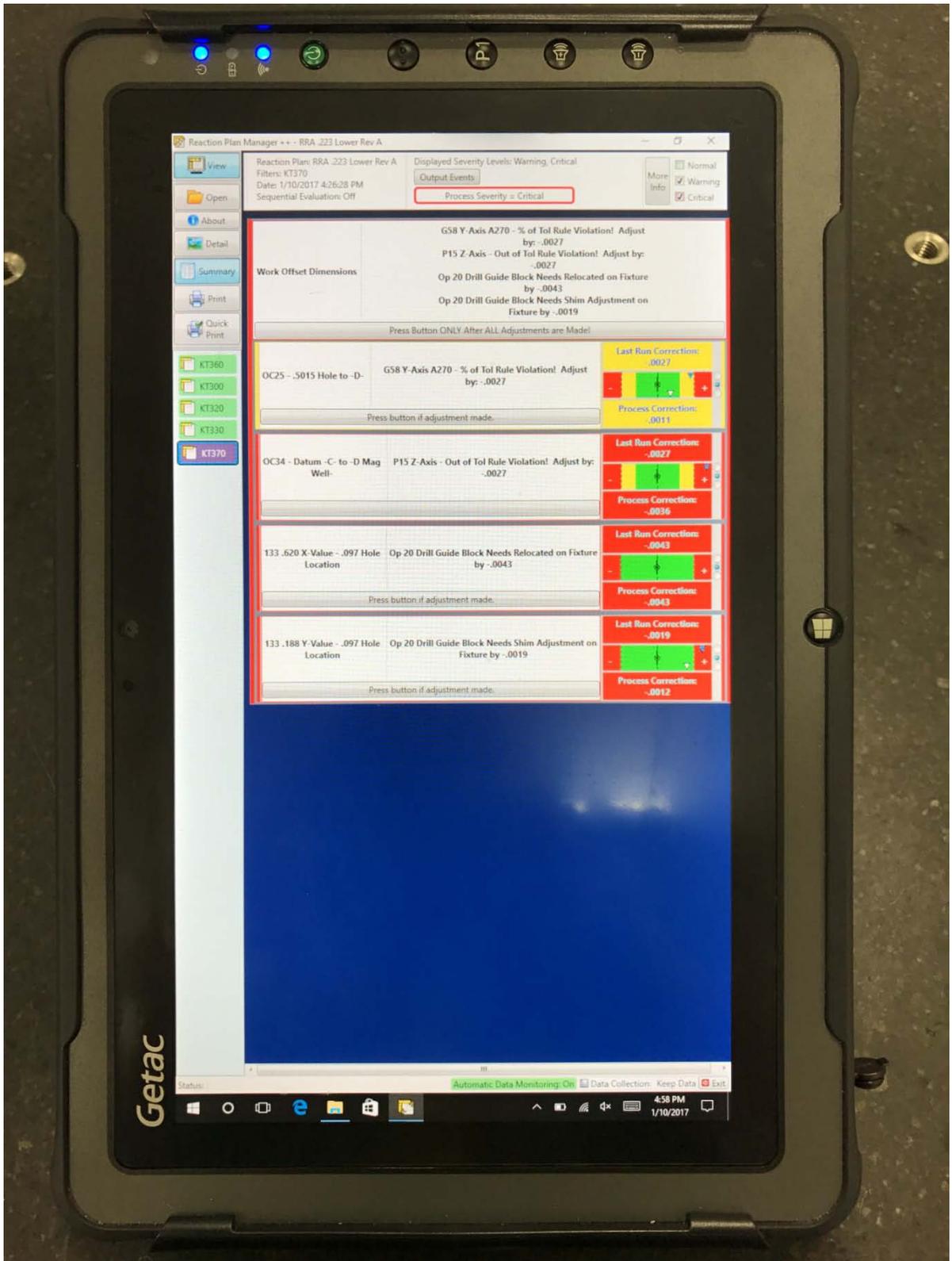


Figure 1



## Operator Station

The Reaction Plan Manager++ software has the ability to push measurement data from the inspection equipment (“Inspection Station”) to computers on the shop floor (“Operator Station”). The data is analyzed at the Operator Station and process adjustment instructions displayed to the operator in real-time. The solution is scalable. You can add multiple Operator Stations to one Inspection Station. There is no printed reports, no waiting for the inspection equipment resources to be available. The part data is filtered at the Inspection Station so the Operator Station only receives data related to the machines in the area. With a click of a button the Operator Station user has access to process control information for each machine in his area.

Kemlab Production Components decided to implement the Operator Station feature by providing a tablet to the area supervisors with Reaction Plan Manager++ installed and configured as Operator Station. The Reaction Plan Manager++ running on the CMM is configured as Inspection Station. When the machine operator measures the part on the CMM (inspection station) the data is automatically pushed to the tablet (Operator Station). The Reaction Plan Manager++ running on the tablet receives and processes the data waiting for the area supervisor to view the Reaction Plan. The area supervisor can carry the tablet to any CNC machine in his area and open the latest Reaction Plan to get the machine adjustment instructions (Figure 2).

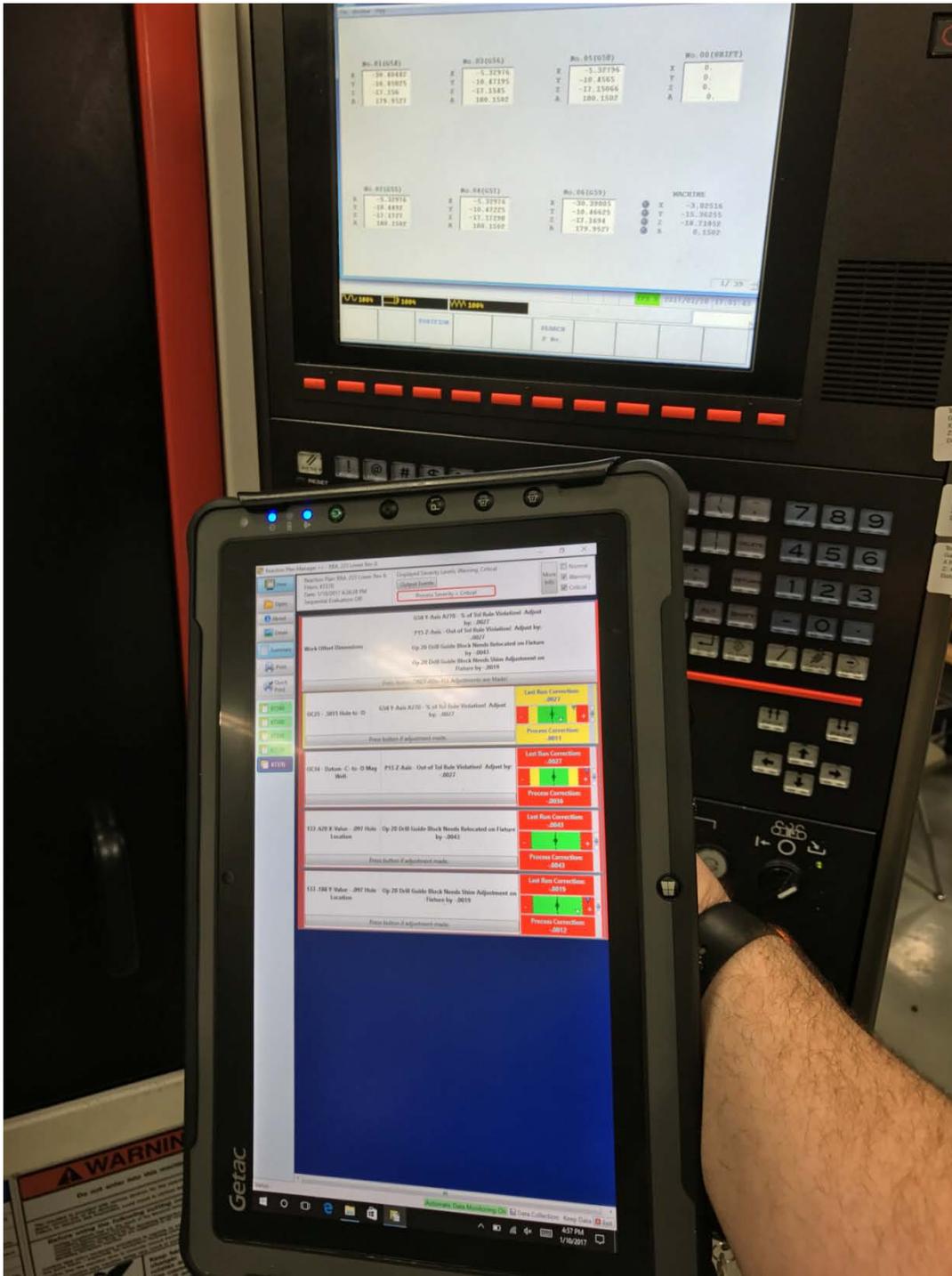


Figure 2



## Process Knowledge Storage

Implementing the Reaction Plan Manager++ software solution forces engineering to resolve how someone should react to part measurement data. The reaction is based on engineering principles and process knowledge. For example, assume an engineer responsible for a machining process knows a specific measurement dimension controls the cutter comp setting for a tool. Based on process knowledge, he understands the process correction should be half the deviation amount and the sign opposite of the measurement deviation. Reaction Plan Manager++ captures this process knowledge in the solution and stores it as a Reaction Plan. When the measurement data is passed to the Reaction Plan, the results tell the operator how to react. As the process evolves, the solution can be updated to yield the optimal reaction.

The Reaction Plans for each firearm component manufacturing process includes a variety of adjustment techniques. Most of them involve controlling the process through tool wear adjustments. Some adjustments are more complex. For example, one tool adjustment affects several other tools. The adjustments (tools) are linked so adjusting one tool could require adjustments to the others. The Reaction Plan for each firearm component has the ability to calculate the adjustments for all the tools in one analysis. The adjustment techniques and calculations are stored in the document for everyone in the organization to use.

## Continuous Training

The greatest benefit of implementing the Reaction Plan Manager++ software is the sharing and distribution of process correction information. Area supervisors get immediate information regarding the manufacturing process as soon as their part is measured. Engineering can update the Reaction Plan Manager++ solution as the process evolves without training each individual operator. The adjustments are in the Reaction Plan.

## Summary

Implementing the Reaction Plan Manager++ software solution for the firearm components reduce machine down time and improve quality by providing process control information. The software gives engineering a tool to capture and share process knowledge in a clear consistent way which significantly reduces the amount of time supporting the manufacturing floor. Area supervisors have more time to focus on managing their department instead of consuming time figuring out how to make machine adjustments.