COLLEGE OF ENGINEERING
GRADO DEPARTMENT OF
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VIRGINIA TECH.

MOOG

Renishaw Probe Optimization

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Background

About Moog, Inc.

Pentair

Our client is the Moog facility located in Radford, VA. This facility was formerly known as Aspen Motion Technologies and was acquired by Moog Inc. for $34 million in 2013. The Aspen plant is a job shop, meaning that every motor or fluid control system that is created is custom made to the needs of the client.

Objective of the Project

RENISHAW
apply innovation™

In late July, the Aspen plant of Moog, Inc. acquired a number of Renishaw probes. These probing systems are mounted onto mills, lathes and a number of other CNC machines.

The machine shop manager has mentioned that it would be beneficial to create a **real-time process monitoring chart** that would display the measurements taken by the probe. This would allow for easy identification of any erratic or out-of-control process.

Data Transfer

1. Data (Inner Diameter, Outer Diameter, and Part Sequence Number) is located on the machine by searching the machine's directory for RESULTS.txt.

2. Data is exported from the machine to an external computer through an RS232 serial port.

python™
CSV

3. Data is read into the external computer through a USB port. Once onto the device, the device will begin to execute a data cleansing script using python. After the data is cleansed, it will be stored in a .csv file stored on the facility's network.

4. Data is exported in real time from the .csv file and visualized in an excel dashboard.

Python Script Workflow:

Parsing File → Export to Data Storage → Export to Visualization

Parsing File: Python script cleans the imported .txt file such that the data is ready to be sent to storage and visualized

Export to Data Storage: Data is sent to a .csv file that is connected to a visualization tool

Export to Visualization: Data is queried from the .csv file and visualized

Project Solution

Phase 1: Locate and Identify Data from Machine

The Renishaw probe data is found within the machine's storage directory and titled RESULTS.txt.

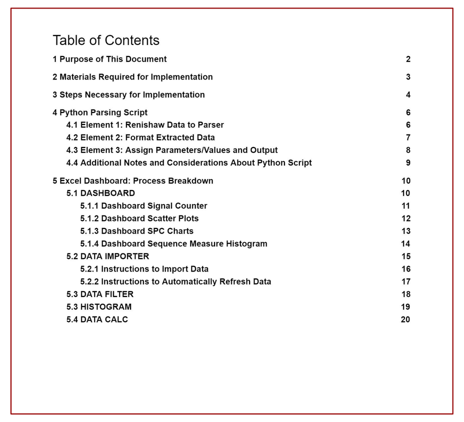
CSV python™

Phase 2: Data Transfer

The .txt file is manually sent from the Okuma machine through the RS232 serial port to an external computer. This computer with the uploaded files serves as a transporter & cleaner of the exported data before it is to be read by the visualization mechanism.

Phase 3: Data Storage and Visualization

Once transferred, the .txt file is converted to .csv and uploaded into a communal folder on the facility's network. From there, it is pulled continuously to the macro-enabled Excel dashboard.



Phase 4: Findings and Implementation Guide

Documentation regarding the setup and implementation was provided so that the team at Moog can replicate or expand the deliverable.

Results

The graphic below shows the script developed the gather the data, format it, and export it to the proper location. Each section of the script is identified with its appropriate label.

```
from time import sleep
import serial
from datetime import datetime, timedelta

port = serial.Serial("/dev/ttyUSB0", 9600, bytesize=serial.SEVINBITS, parity=serial.PARITY
port.flush()
last_received = datetime.now()
string = ''
while true:
        if port.in_waiting:
            received = port.read_all().decode('utf-8')
            string += received
            last_received = datetime.now()
            print(f'received: {received}')

        if (datetime.now() - last_received) > timedelta(seconds=5):
            break
        sleep(0.1)

string = string.strip()
lines = string.split('\n')
lines = [l.strip() for l in lines]
lines = [l.replace('    ', '\t') for l in lines]
lines = [l.replace('\t\t', '\t') for l in lines]
lines = [l.replace('\t\t', '\t') for l in lines]
lines = [l.replace('\t\t', '\t') for l in lines]
lines = [l.strip() for l in lines]
lines = [l for l in lines if l[1] != '\0']

print('lines', lines)

for line in lines:
    parameter, value = line.split('\t')
    parameter = parameter.strip()
    value = value.strip()
    with open('file.csv', 'a') as f:
        f.write(f'{parameter},{value}\r\n')
```

Import Data from Machine

Format Imported Data

Export to .csv with Values Assigned to Keys

The graphic below shows the final technical deliverable for the client. The deliverable is a robust dashboard in which machinists can be ensured that they are within control limits while in production. This team was not able to implement the dashboard on the machines due to the impact of COVID-19. In response, the team developed an implementation guide detailing how to set up connection between the machine and the computer, how to use and adjust the parsing script (python) and how to setup and adjust the dashboard as needed.

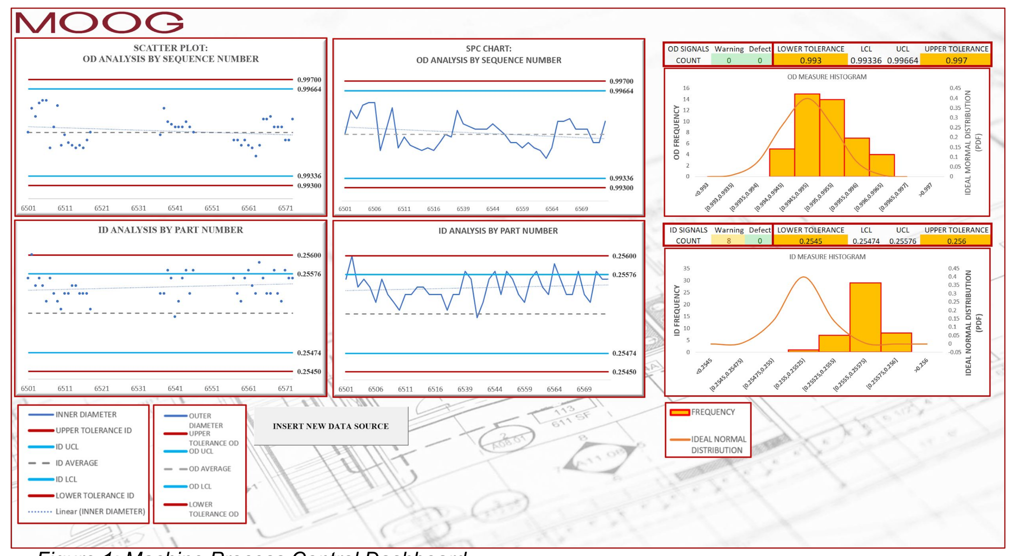


Figure 1: Machine Process Control Dashboard

Impact

Due to the real-time monitoring nature of this data visualization tool, machinists can continue producing parts knowing that the process is within control. This means that the likelihood of a "streak" of defective parts is significantly diminished. Unfortunately, the team was not able to fully implement the solution due to COVID-19. Therefore, the calculations for total project impact are based on assumptions, fixed with estimates on likelihood of execution.

Event	Likelihood of Execution	Impact (if executed)	Adjusted Impact Value
1 new sale created as a result of the visualization tool	10%	$500,000 (assumed average sale revenue)	$50,000
20 hours per year of saved time due to more lean production	90%	$1,500 (assuming $25/hr wages, 20 hrs/year, 3 years)	$1350
1 hr (cumulative) on training and using the dashboard	100%	$75 (assuming $25/hr wages, 3 years)	$-75
3 hrs setup (one-time) & 10 hrs of maintenance and updates per year	90%	$825	$-742.5
		Total (Adj.) Impact Value:	**$50,542**

This quantitative estimation makes several long-term assumptions that have a high probability of being incorrect. However, while the economic impact of this project is not definitive, the process improvement that will result from the visualization tool could lead to less waste (defects), higher machinist efficiency (less time wasted on producing defects), and even higher machinist engagement.

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