Measuring and Improving Cell Capability

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ABSTRACT & RESEARCH OBJECTIVE

Improving part quality is vital to the modern automotive industry. This goal is being accomplished through increased inspections, including on-line inspections, Statistical Process Control (SPC) sampling, and 100% inspection on critical dimensions.

Increasingly this data is being gathered by multiple highly sophisticated sensors. Each sensor is capable of measuring many variables. By analyzing both the average and variance of all the variables, significant performance gains can be made in sensor and cell capability.

The objectives of this research are to build more reliable sensors, to be able to analyze sensor performance, and to be able to measure and improve cell capability.

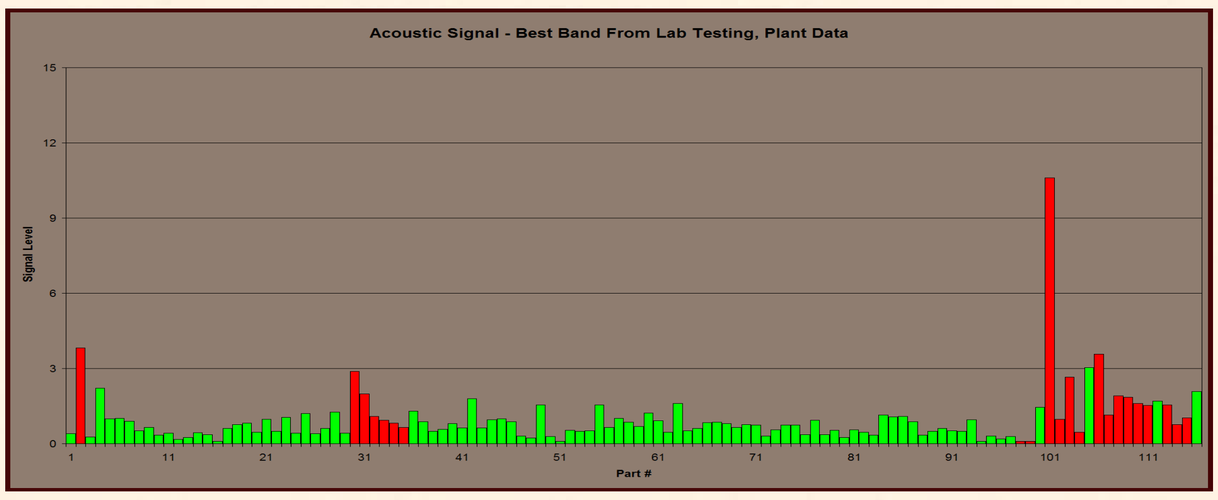
IMPORTANCE OF LOW DEFECT RATES

Rate	Parts / Hour	Parts / Car
Good Parts	3600 Good Parts / Hour	5000 Good Parts = 1 Car
1000 ppm defects/part	Defect Every 20 Min.	0.6% Good Cars
1 ppm defects/part	Defect Every 2 Weeks	99.5% Good Cars
0.1 ppm defects/part	Defect Every 20 Weeks	99.95% Good Cars
0.001 ppm defects/part	Defect Every 40 Years	99.9995% Good Cars

EXAMPLE #1: ACOUSTIC DETECTION

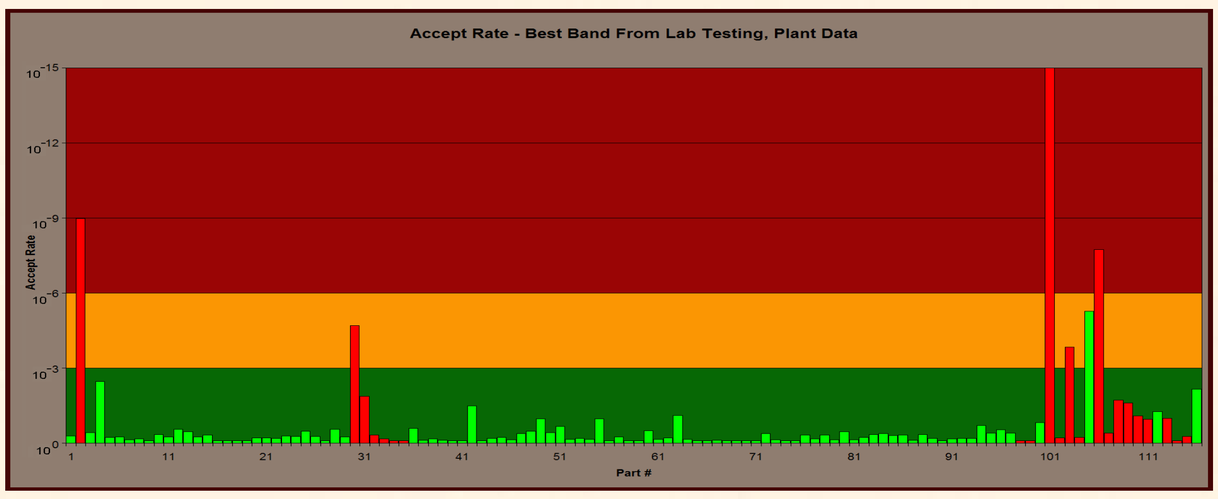
Acoustic Sensor:
- Signal processing algorithms affects sensor performance.
- Accept rate can be used to estimate sensor performance.

STEP 1: INITIAL DATA



Green = Good Parts Red = Known Defects

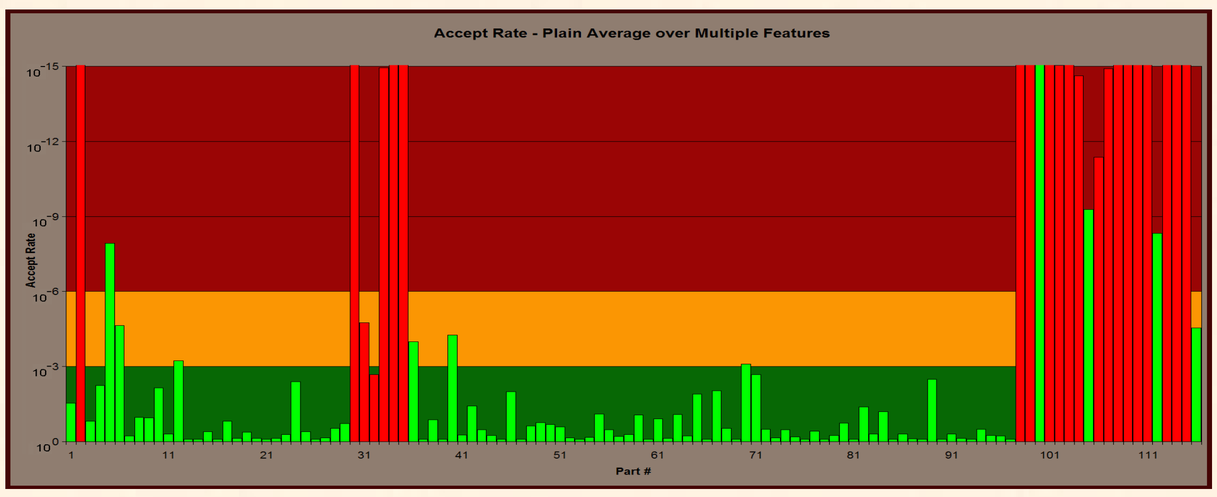
STEP 2: GRAPH BY ACCEPT RATE



Goal:
- Green bars in Dark Green zone.
- Red bars in Dark Red Zone.
- No bars in Amber Zone.

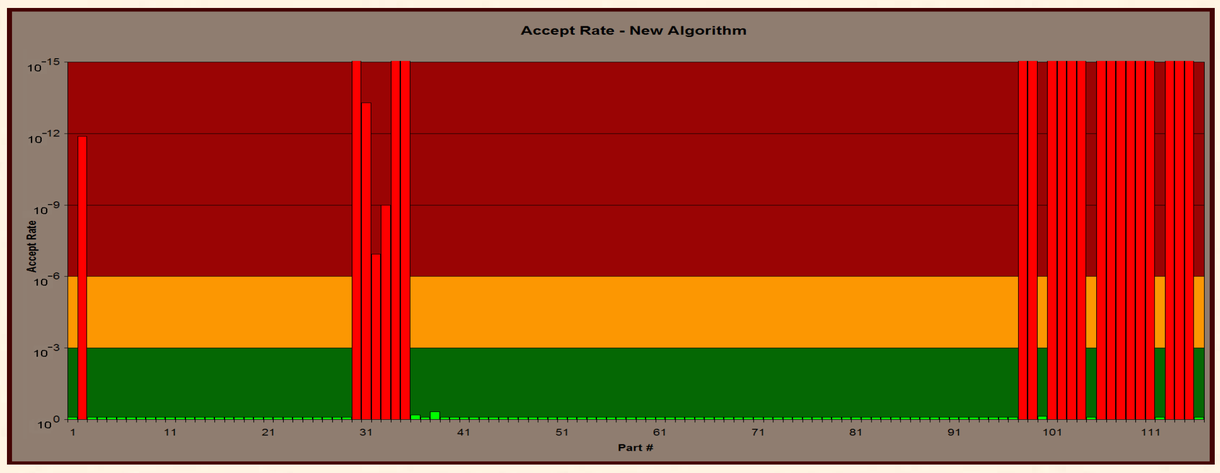
Problem: Many Red Rejects in Green Zone.

STEP 3: PLAIN AVERAGING



Affect of Averaging:
- Averaging improves results.
- Does not consistently fail all bad parts.

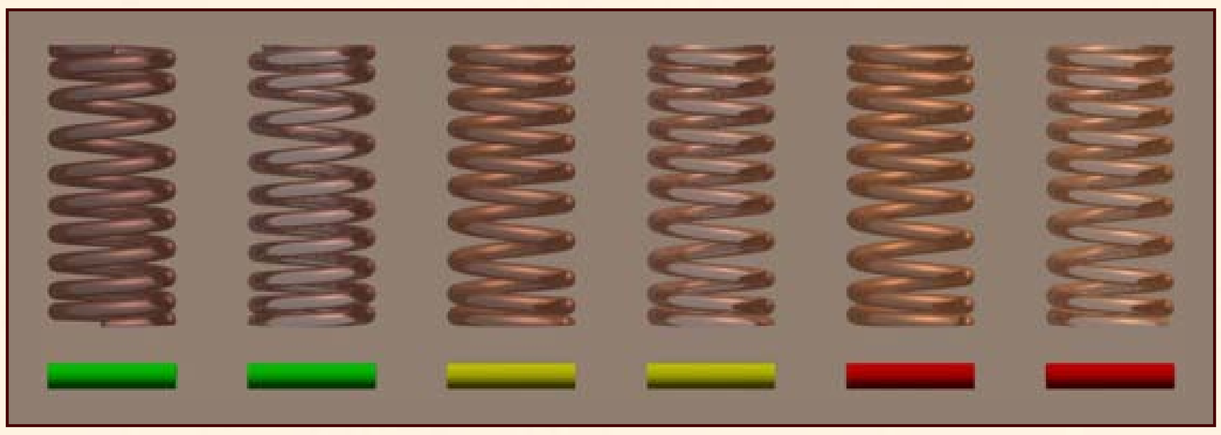
STEP 4: NEW MULTI-VARIATE ALGORITHM



Result:
- High Accept Rate for Good Parts
- High Reject Rate for Defects
- Excellent Results
- Multi-variate algorithm requires verification with Plant Data

EXAMPLE #2: SPRING ORIENTATION

Spring orientation:
- Affects engine performance and emmissions.
- Reliable orientation detector is required.
- How do we assess tester reliability?
- Extremely costly to assess manually.
- Automated reliability analysis was required.
- 1.5 million multi-coloured springs were assessed.



Green = Good Parts Yellow = False Accepts Red = Known Defects

SOLUTION: MULTI-VARIATE ALGORITHM

Algorithm	False Accepts
Original (Lab) Algorithm	100 ppm False Accepts
Proposed Algorithm	0 False Accepts
Multi-Variate Verification	200 Warnings / 0 False Accepts

Result:
- No False Accepts
- Multi-variate algorithm warned on unusual production.
- Customer is Protected.
- 1.5 million part sample size.

NEW INSTRUMENTED CELL

Machine Tool Sensors:
- Vibration
- Acoustic
- Clamps on Workpiece
- Tool Breakage

CMM Sensing:
- Dimensional
- Vision
- Surface
- Feature Presence

Goal: To improve cell capability with new multi-variate algorithms.

CONCLUSIONS

Conclusions:
- Better software can inexpensively enhance gauge performance.
- New methods of enhancing guage reliability.
- More reliable good / bad product detection.
- Warnings on bad measurements & unusual product.
- Accurate Predictions on Gauge Reliability

Next Step:
- Cell Scale testing of multi-variate algorithms.

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