Process Monitoring

Spot Welding
Riveting
Stamping
Clinching
Crimping
Press Fitting

Quality without Question
In-process monitoring methodology

- Repetitive manufacturing processes such as crimping and stamping exert force during the material forming process.
- The measured resistance during this material forming and compression process results in a characteristic force signature or “pulse”.
- The repeatability of this pulse is directly related to the capability of the process and the quality of the part produced.
- Monitoring the pulse of every machine cycle for repeatability is an effective method for assurance of quality of every part produced, and an indicator of the health of the process.

TAKING THE pulse OF YOUR PROCESS

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Quality without Question
In-process monitoring methodology

• A healthy process is repeatable and will ensure quality parts are produced.
• An unhealthy process may continue to produce good parts but will contribute to quality issues, scrap material, maintenance issues, and machine downtime.
• Monitoring the pulse of the process is an effective method for assurance of part quality, and early detection of changing conditions in the process that might otherwise lead to quality issues, scrap, and unplanned machine downtime.
In-process monitoring methodology

Each machine cycle involving force forming or joining of materials should result in a repeatable pulse …

Examples of conditions in the manufacturing process that can result in an irregular pulse include:

- Change in material – hardness, shape, concentricity, coating
- Tooling wear or breakage
- Change in part dimension
- Misalignment or incorrect presentation and/or insertion of materials
- Degradation of the machine condition such as broken or loose components, loss of lubrication
In-process monitoring methodology

Taking a closer look at the resulting force signature from a production part…
In-process monitoring methodology

Illustration of a force signature from a defective part...
In-process monitoring methodology

Illustration of a force signature from a defective part…
In-process monitoring methodology

The process trend - what is a good part, what is not…
In-process monitoring methodology

Illustration of process drift and degradation...

Typical scenarios that can cause *Process Drift*:
- Lubrication
- Tooling wear
- Machine condition or maintenance
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Illustration of a random defect termed “lightning strike”...

Typical scenarios that can cause Lightning Strikes:
- Scrap material in tooling
- Wrong material
- Missing material
- Misalignment of material
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Process Stability...

Repetitive and stable processes typically generate a consistent and repeatable pulse. To optimize performance variation in the pulse must be minimized.

STABLE PROCESS

UNSTABLE PROCESS

All factors of the process can affect the stability and must be taken into consideration. We are dealing with the entire process not just the part.
In-process monitoring methodology

How the system controls defective and suspect parts...

- Annunciates the defect condition to operator
- Stops machine automatically
- Part isolated for secondary inspection

- Logs and time stamps data from every production part
- Data can be transferred to USB stick or collected by plant Network
In-process monitoring methodology

Typical system configuration...

MACHINE INTERFACE FOR CONTROL OF PART DEFECTS

OPERATOR INTERFACE
- ANNUNCIATE DEFECT
- DISPLAY PROCESS TREND
- TOTAL PARTS PRODUCED
- SCRAP RATE

TAKING THE pulse OF YOUR PROCESS

DYNAMIC PIEZO FORCE SENSOR CAPTURES THE FORCE DURING METAL FORMING PROCESS

PVM5000 ANALYZES THE FORCE SIGNATURE, DISCRIMINATES PROCESS VARIATIONS THAT ARE CHARACTERISTIC OF PART DEFECTS, PASS/FAIL

MACHINE APPLICATION

GO / NO GO

ANNUNCIATE DEFECT
DISPLAY PROCESS TREND
TOTAL PARTS PRODUCED
SCRAP RATE

ISO 9001 2008
FM 64157

Quality without Question
In-process monitoring

Application - End forming & Hose Crimping
Current Inspection & QC Practices

- Dimensional measurement and/or physical Inspection of sample parts…
  - Catch gross part defects
  - Prevent faulty parts from reaching the customer

- Inherent Shortcomings…
  - Detection of material flaws – hardness, thickness, cracks
  - Detection of hidden, non-visible defects
  - Manual inspection processes with high dependence on operator
  - Post process inspection adding time and costs
  - Limited traceability
In-process monitoring

Capable to detect...

- Change in part dimension

- Excessive variation or degradation in the process that will ultimately contribute to quality issues, increased scrap, and machine downtime:
  - Tooling wear, gripper and/or guide wear
  - Change in raw material quality or consistency (hardness, concentricity, coating)
  - Loss of lubrication
  - Incorrect material presentation (insertion, automatic and manual feed methods)
  - Incorrect machine setup (misalignment issues, loose components, etc.)
In-process monitoring

**Force signature from a production part...**

- The force signature profile from each production part is compared to the force signature profile of a reference “good” part.
In-process monitoring

Illustration of a good part....

1. Initial Tool Contact
2. Tooling Insert
3. Tube Collapse & Forming

In-process monitoring.
In-process monitoring

Illustration of a defective part....

THE SHAPE OF THE SIGNATURE SHAPE HAS CLEARLY CHANGED IN REGION 2 & 3 AND DETECTED DURING THE TUBE FORMING PROCESS

1 INITIAL TOOL CONTACT
2 TOOLING INSERT
3 TUBE COLLAPSE & FORMING

ISO 9001:2008
FM 64157

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In-process monitoring

The product...

Sensor Interface
- FORCE SENSOR
- POSITION SENSOR

Part/WO Selection
- BAR CODE READER

Central Data Base
ETHERNET

PVM5000
Process Variation Monitor

Equipment Control
- MACHINE/PRESS

Traceability
- REAL TIME DATA LOGGING

Productivity Reporting
- PRODUCTIVITY
- PRODUCTION
- QUALITY – Process CPK, Scrap Count

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Quality without Question
In-process monitoring methodology

Benefits ...

- 100% monitoring of parts for assurance of quality
- Early detection of degrading process or machine conditions
- Eliminates the potential for human error
- Reduces the risk of generating unnecessary scrap
- Reduces the risk of supplying defective material to customer
- In-process monitoring does not reduce machine processing time
- Traceability – 100% traceability of parts produced
- Automates and error proofs the monitoring of the process and part quality
Eliminating Defects for over 30 years