NIST MEP Industrial Forum Monitoring, Diagnostics, and Prognostics for Manufacturing Operations

Overall case studies and perspectives – Small and Medium-sized Manufacturers in Virginia

Presented by:
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GENEDGE – Virginia MEP
AGENDA

- Small Manufacturers overview
  - Equipment types
  - Maintenance functions
  - Process monitoring
  - Pressing needs
- Midsized Manufacturers
  - Equipment types
  - Maintenance functions
  - Process monitoring
  - Pressing needs
- CASE Study
Small Manufacturers

- **Equipment types**
  - Manual, simple controls, little or no PLC’s, No touch screens
  - Exceptions, Chemical industries & Print houses
- **Maintenance functions**
  - Either NONE (operators fix), or small, (1-2 man)
  - No written PM’s or schedule, run to failure
  - OEM’s may make annual “tune up” visit
- **Process monitoring**
  - Usually paperwork (excel) for schedules & reporting performance(output)
  - Some have simple MRP system
  - Data collected is seldom analyzed
- **Most pressing needs**
  - Resources to attend to simple PM tasks
    - Knowledgeable Technical personnel
    - Time in the production schedule
Mid-sized Manufacturers

- Equipment types
  - Depends on process needs
    - Fully automated, CNC/PLC controlled
    - Older batch type, usually start operations
  - Most PLC controlled, w/touch screens
  - Little to no interconnect ability
  - Some rudimentary sensor monitoring and reporting on individual equipment basis
  - Exceptions, Chemical industries & Print houses, as above

- Maintenance functions
  - Small to mid sized crew, mostly on day shift
  - Some with CMMS system for PM’s and work orders
  - Lack of resources to make improvements – fire fighting is the norm
  - Maintenance personnel are sometimes setup persons
  - Aging workforce, no one to replace those retiring
Process monitoring

- Some – if MRP system has proper modules
- Planning & scheduling using MRP/ERP system
- Data collected on quality, output, and sometimes downtime (gross)
  - Data dumped to spreadsheets, seldom analyzed for trends
- Some use of digital displays in process areas

Challenges/Pressing needs

- Production output over-rides PM scheduling
- No time for improvements – breakdown mode
- Difficult to cost justify improved technology, especially on existing equipment
  - Need financial incentives to pay for these
- ERP systems usually do a poor job of supporting maintenance functions
- Lack of on-site IT personnel, if some they usually handle ERP issues
- Difficulty finding technical employees to replace those retiring
ACME Extrusion has a current PM program carried out by two maintenance technicians. These technicians are scheduling and recording the PM activities using MS Excel and a paperwork based document system. Maintenance also has a CMMS system (Faciliworks) that was installed in October 2012. So far almost 9000 work orders have been recorded in the system. Spare parts were inventoried (min/max system) and were added one and a half years ago, but since the parts crib person has left, the system has not been kept up. Other features of the system, such as breakdown history has not been used as of yet.

There is a lack of a formal PM documentation and equipment history record keeping system. Some PM’s are written for existing equipment, excel spreadsheets keep track of purchases, but there is no integrating system to pull all this together. Maintenance personnel mostly conduct the PM’s from memory not documentation. In addition, due to production pressure, the maintenance personnel are not always given the time to conduct their PM activities. There is a lot of daily "hot" jobs that sometimes prevent maintenance from doing their work.
Mid-sized Manufacturers  - Case Study

- Background facts
  - OEM Tier 2 automotive component supplier
  - 200,000 ft² facility
  - 230 employees, four shifts – 24/7

- Maintenance Function
  - 17 person crew
  - Scheduled PM’s
  - TPM implemented, operator conducted autonomous maintenance
  - Fully staffed & equipped to repair major machine components – i.e. spindles, etc.
  - World class 5S in maintenance areas
Mid-sized Manufacturers - Case Study

- Equipment types
  - CNC multi-axis machining centers – 64
  - Automated parts washing equipment – 6 lines
  - Robotic part inspection in conditioned room – 100% inspection
  - CMM part inspection laboratory – to be replaced with CT scanning
  - All interconnected using Tableau business intelligence software.
    - Home grown eBPD system
    - Collected outputs
      - Output by work cell
      - Quality from automated inspection system
      - Tool consumption
      - Changeover times
      - Downtime
      - Safety performance
      - Supply usage
      - Fixture inspection frequency
      - Others

Screen shots to follow
### Cell Projection

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<thead>
<tr>
<th>Part Numbers</th>
<th>Efficiency</th>
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<td>94%</td>
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### Production Trend

- **March 12, 2018**
- **05:00 PM**
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<th>Totals</th>
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<td>484</td>
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**Production Trend**

March 12, 2018
05:10 PM

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Red Areas Indicate Machine was Down

March 12, 2018
05:11 PM
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<tbody>
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**F700041** Safety Integra...
**F700042** Safety Integra...
**F700047** Charging doo...
**F700149** Spindle clam...
**F700154** Magazine no...
**F700158** Acknowledge...
**F700159** Stop at cycle...
**F700247** Magazine Co...
**F700257** Q-axis: not in...
**F700263** Override or 0...
**F700454** Q axis swivell...
**F700532** Tool Inspect...
**F700560** Magazine cle...
**F700605** Coolant: Swa...
**F700609** Cooling lubric...
**F700638** Coolant: tank...
**F700639** Coolant: tank...
**F700646** Coolant: circu...
**F700850** Safety Integra...
**F700851** Safety Integra...

**StatusAuto** Null
**StatusGreen** Null
**StatusJog** Null
**StatusMDA** Null
**StatusRed** Null
**StatusYellow** Null
Mid-sized Manufacturers - Case Study

• Challenges:
  • Want to move to next generation – “Machine Health”
  • Costs are prohibitive for retrofit to existing machines
    • OK to specify on new equipment
    • Need some form of financial incentive to help offset costs
  • Maintenance technician knowledge base – lacking
    • Home grown systems & equipment lack troubleshooting & standardized work documents
      • Ideal would be tablet based videos
      • Little resources to dedicate to creating these training aids
  • Network logs all faults coming from equipment, but little to no diagnosis done with data, currently data is analyzed manually by plant engineers, who will notify Maintenance if they notice repeating faults.
  • Current robotic equipment lack specific fault sensors, a problem is detected when work backs up exit conveyors and trips a “full” sensor.
Case Study – The future - Brinkhaus Toolscope

Integration of the system into the machine tool

Diagram showing integration

- **Control panel visualisation**
  - External sensors for motor output, structure-borne sound, acceleration

- **ToolScope**
  - Alarm messages
    - Internal machine sensors (torques, etc.)

- **Machine**

- **Siemens**
  - Rectifier/intermediate circuit
  - NCU
  - Axis controller
  - Axis controller
Summary and final thoughts

- Recent technological advancements from SMMs
  - Equipment with PLC interface to report status, production data mostly
  - CMMS in use, most limited to writing/storing work orders
- Sensor/human data beneficially used by SMMs
  - As above PLCs to capture data
  - Equipment history data – captured but seldom used to do predictive maintenance
- Large manufacturers information/intelligence to pass on to SMMs
  - Linking PLC data streams to central computer system to create reports
  - We are not using the available data from our systems effectively too.
Thank You