National Institute of Standards and Technology
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GENEDGE alliance

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

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

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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

Mid-sized Manufacturers (cont.)

- 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

Mid-sized Manufacturers (cont.)

Typical findings from E3 assessments

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 f² 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

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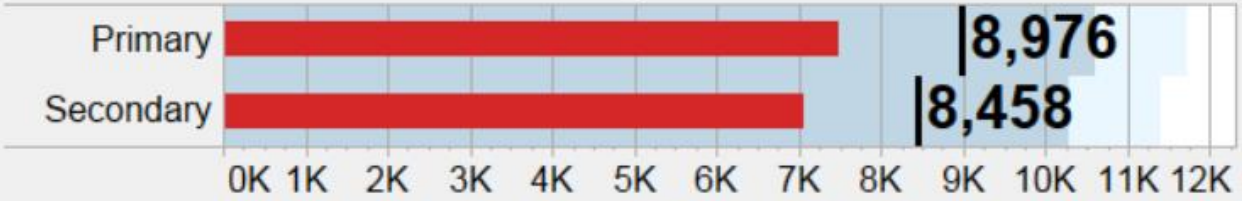
- Equipment types
  - CNC multi-axis machining centers – 64
  - Automated parts washing equipment – 6 lines
  - Robotic part inspection in conditioned room – 100% inspection
  - CMM part inspection laboratory – to be replaced with CT scanning
  - All interconnected using Tebleau business intelligence 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

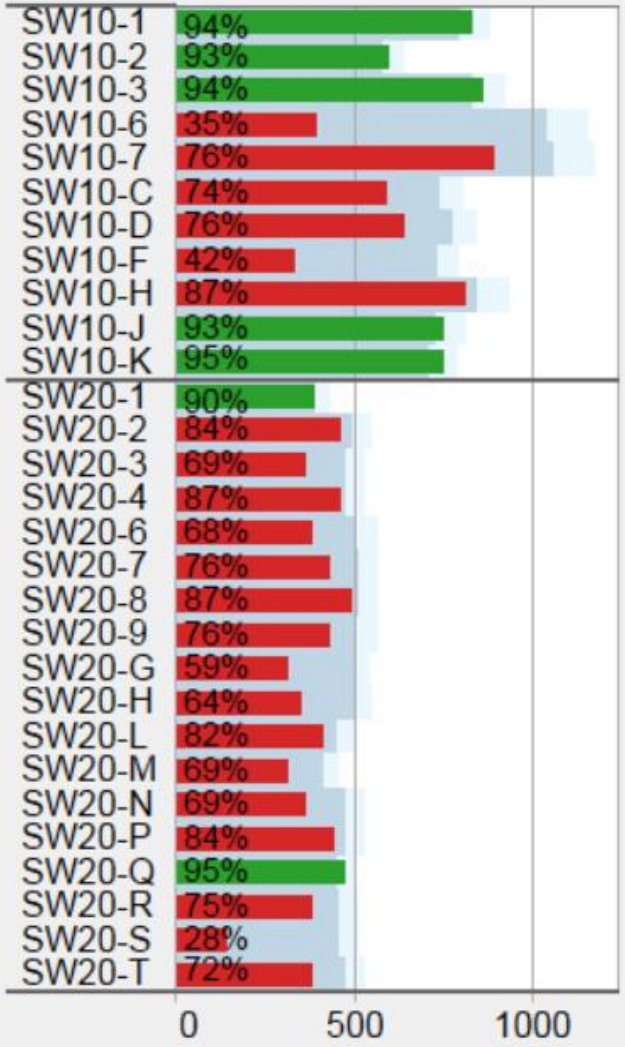
Cell Projection



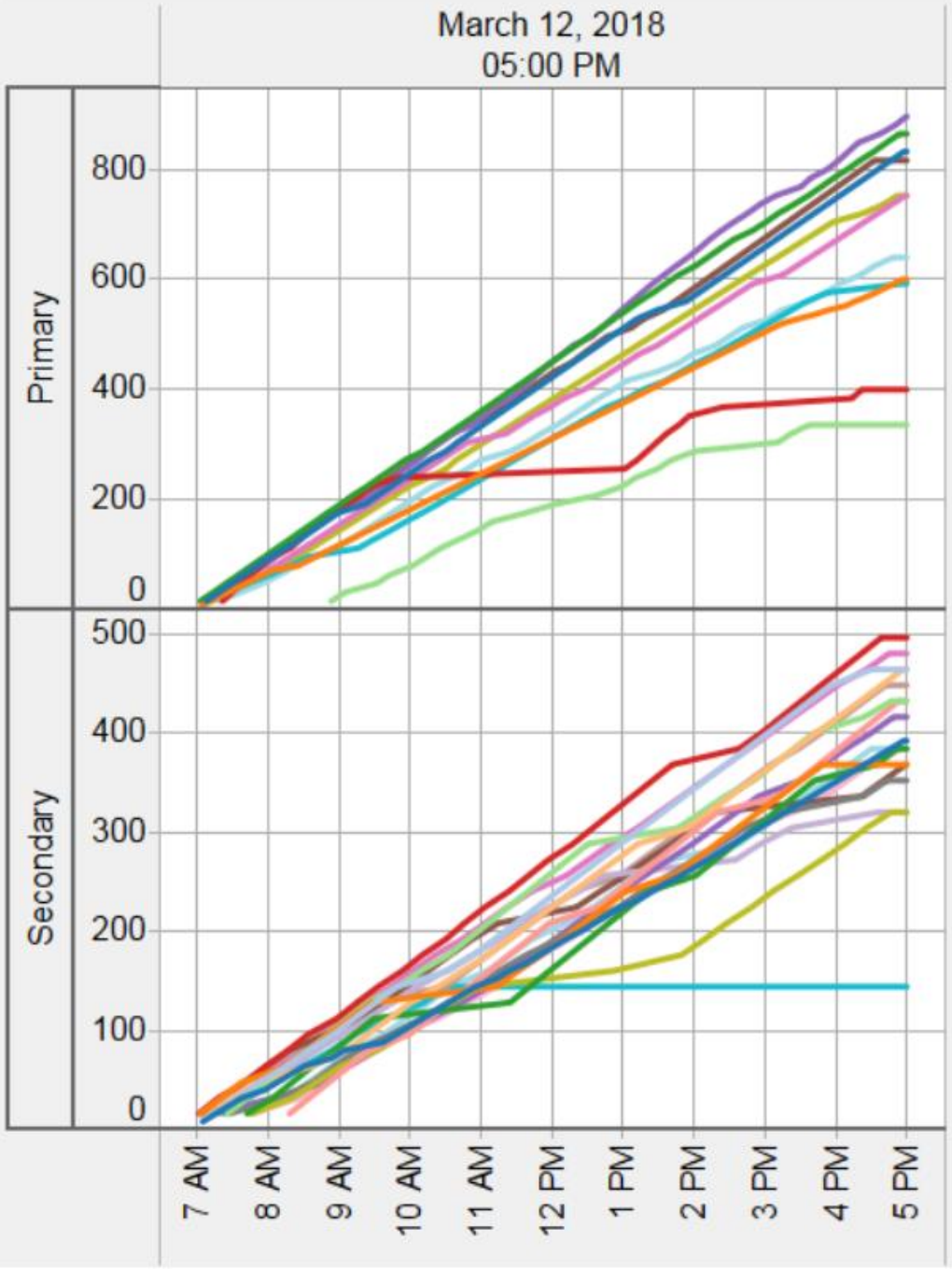
Part Numbers

SW10-1	25.0206-3020.1	832
SW10-2	06.2104-0207.1	600
SW10-3	06.2104-0240.1	864
SW10-6	10.0206-3071.1	368
	25.0206-3051.1	32
SW10-7	25.0206-3035.1	896
SW10-C	25.0206-4002.1	576
	25.0206-3081.1	16
SW10-D	06.2104-0268.1	640
SW10-F	25.0206-3029.1	288
	25.0206-3023.1	48
SW10-H	25.0206-3033.1	816
SW10-J	25.0206-4002.1	752
SW10-K	25.0206-3029.1	752
SW20-1	06.2104-0207.1	392
SW20-2	25.0206-3033.1	464
SW20-3	06.2104-0240.1	368
SW20-4	06.2104-0240.1	464
SW20-6	25.0206-3035.1	384
SW20-7	10.0206-3071.1	432
SW20-8	10.0206-3071.1	496
SW20-9	25.0206-3035.1	432
SW20-G	06.2104-0257.1	160
	06.2104-0268.1	160
SW20-H	06.2104-0257.1	320
	06.2104-0268.1	32
SW20-L	25.0206-4002.1	32
	25.0206-3020.1	384
SW20-M	10.0206-3099.1	304
	10.0206-3125.1	16
SW20-N	25.0206-3029.1	368
SW20-P	25.0206-3029.1	448
SW20-Q	25.0206-3020.1	480
SW20-R	25.0206-4002.1	384
SW20-S	25.0206-4002.1	144
SW20-T	25.0206-3029.1	384

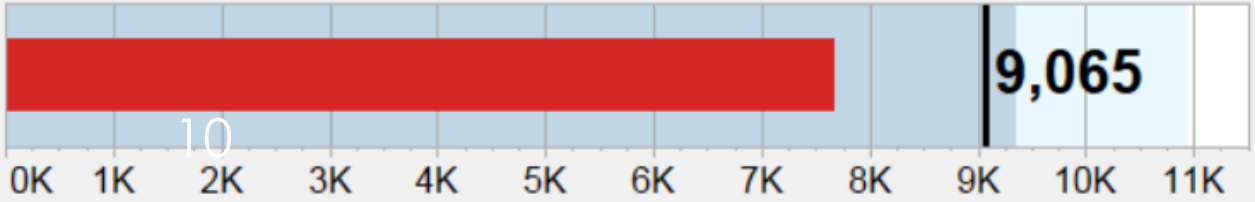
Efficiency



Production Trend



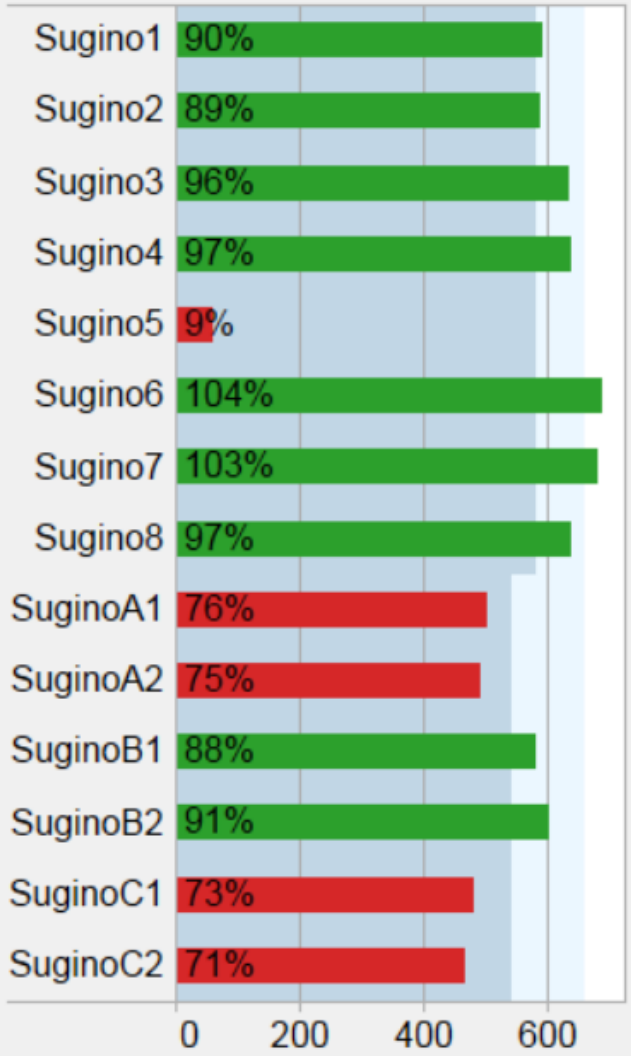
Cell Projection



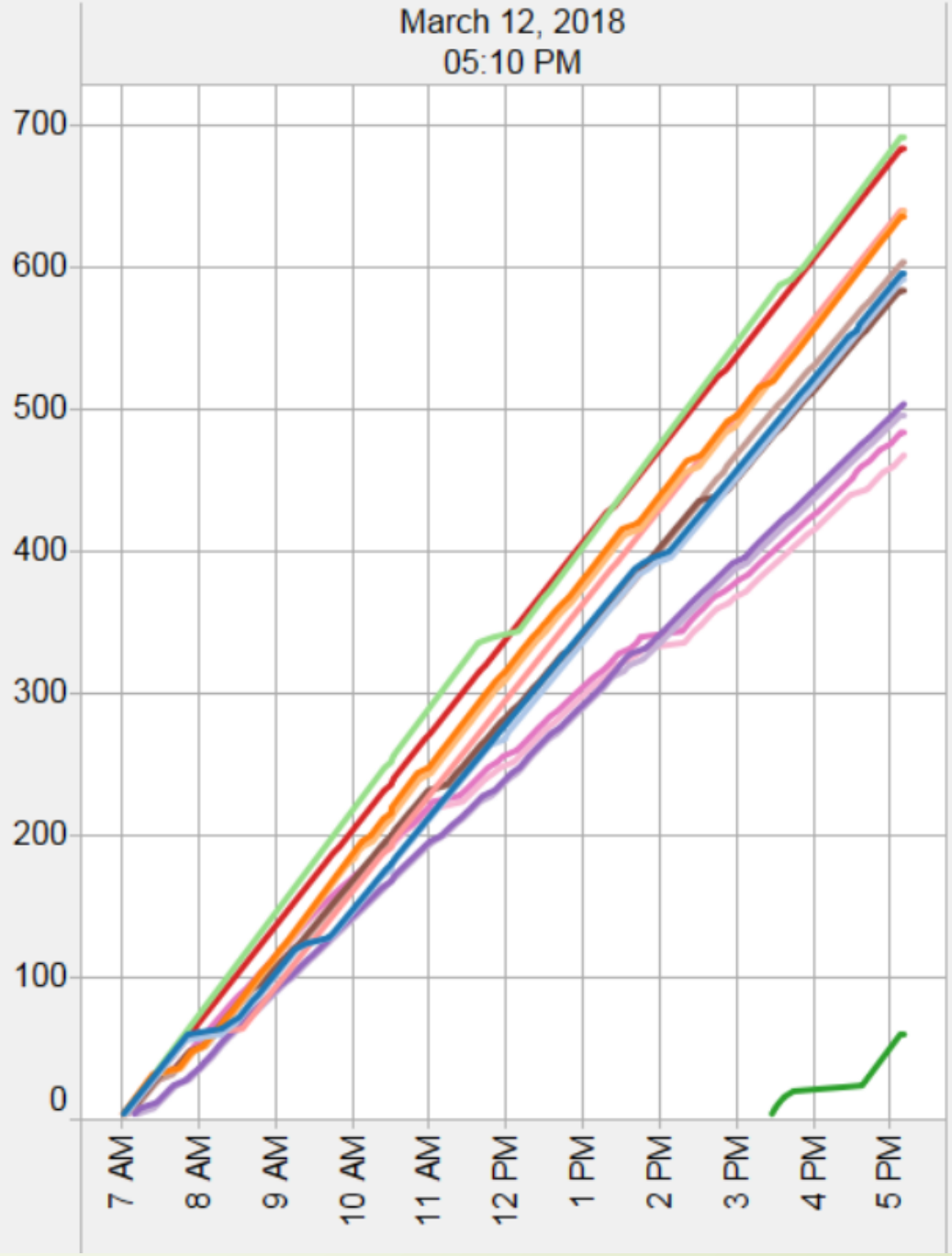
Totals

Sugino1	596
Sugino2	592
Sugino3	636
Sugino4	640
Sugino5	60
Sugino6	692
Sugino7	684
Sugino8	640
SuginoA1	504
SuginoA2	496
SuginoB1	584
SuginoB2	604
SuginoC1	484
SuginoC2	468

Efficiency



Production Trend



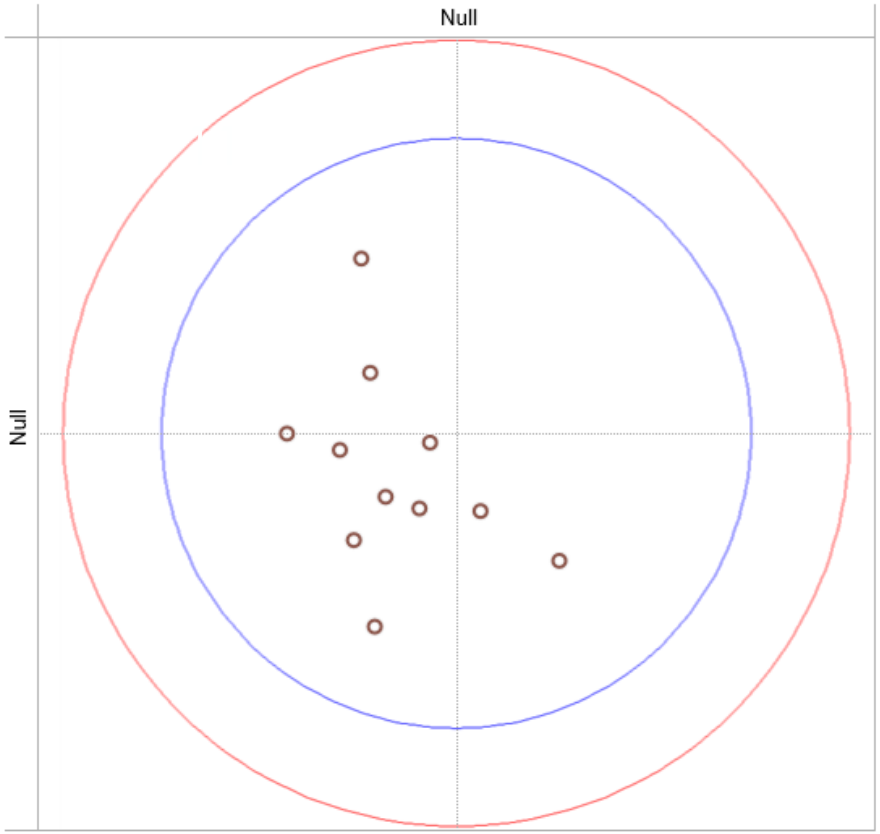
Machine

- Sugino1
- Sugino2
- Sugino3
- Sugino4
- Sugino5
- Sugino6
- Sugino7
- Sugino8
- SuginoA1
- SuginoA2
- SuginoB1
- SuginoB2
- SuginoC1
- SuginoC2

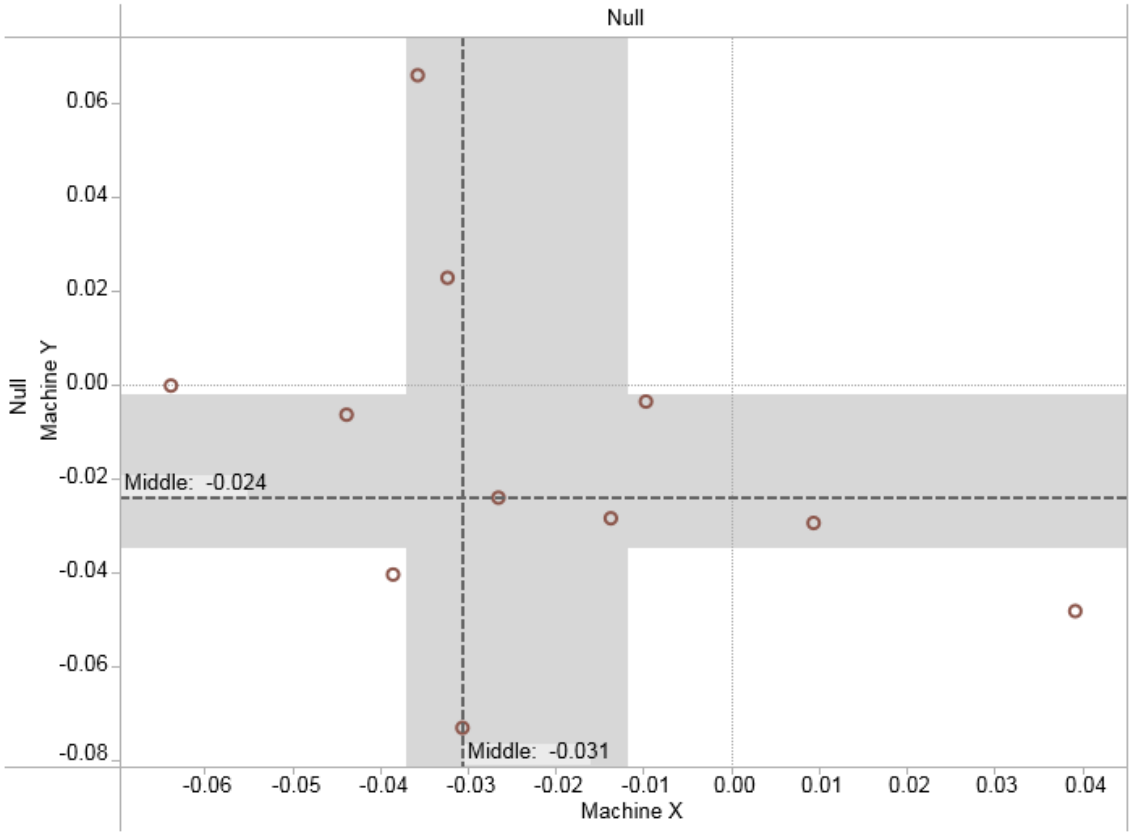
Recent Part Numbers

ABC	0240
	3071
	4002
1 thru 4	0207
	3029
	3035
	3059

Relative to True Position Spec



Actual Deviation From Nominal Dimension



MostRecentFlag

- [ ] Older Events
- [x] Most Recent

Time Window (Last 10 Days Max)

Last 10 days

OK-NOK

- [x] NOK
- [x] OK

Machine

T1
T2
T6

Part Number

1453
1740

Face

A
B
C
D
E
F

Fixture

AL
AR
BL
BR
CL
CR
DL
DR

Feature

A1_SO_POS
A7_ESV_POS
A8_SOAS_POS
A12_SG_POS
A15_M4_POS
A30_CONN_POS
A34_CHN_POS
A53_SEN_POS
A80_ADRIN_POS
B5_CHN_POS
B5_PORT_POS
B6_CHN_POS
B6_PORT_POS
B7_CHN_POS
B7_LOC_POS
B8_LOC_POS
B10_DMP_POS
B30_CON_POS15
C1_ACC29_POS
C1_ACC_POS
C5_CBOR_POS
C7_CBOR_POS
C21_SUCT_POS
D1_CHN_POS
D1_PORT_POS
D2_CHN_POS
D2_PORT_POS
D3_CHN_POS
D3_PORT_POS

Choose Item to Mark By Color

Machine

Color Legend

T6

Choose Item to Mark By Shape

OK/NOK

Shape Legend

OK

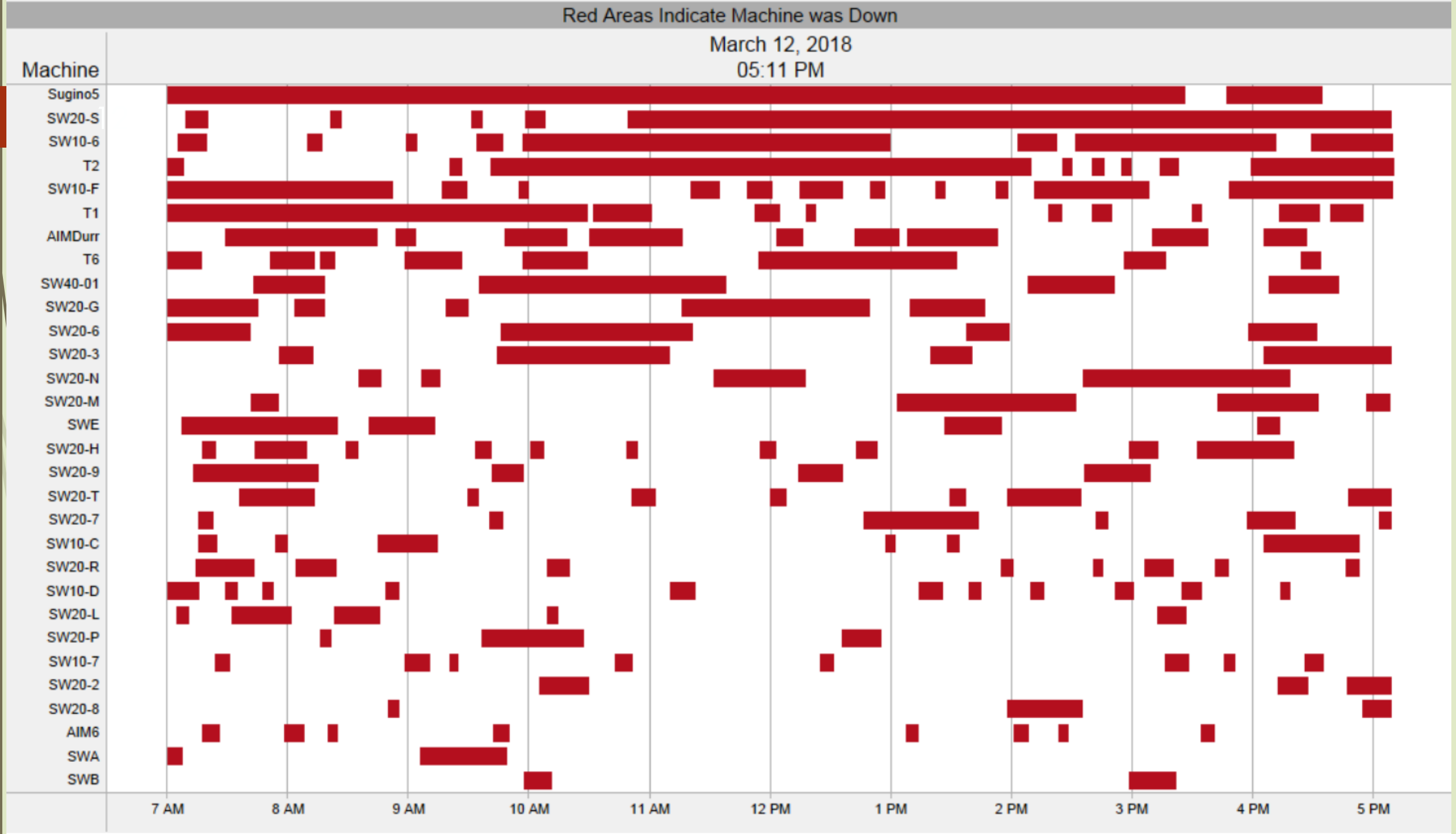
Choose Item to Mark By Size

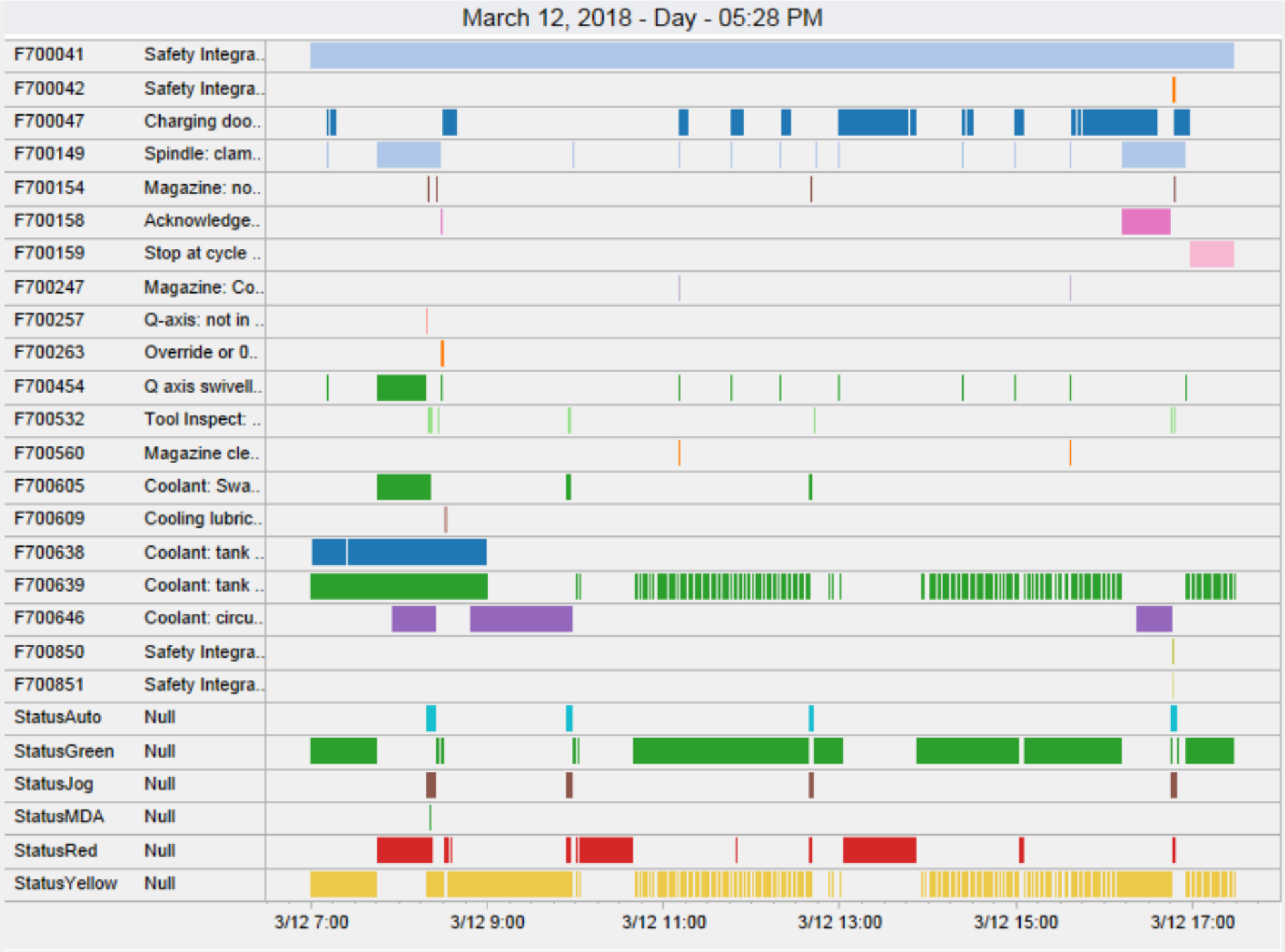
None

Size Legend

Null

Undo | Redo | Revert | Refresh | Pause | *Original View | Edit | Share | Download


Red Areas Indicate Machine was Down
March 12, 2018
05:11 PM
Machine
Sugino5
SW20-S
SW10-6
T2
SW10-F
T1
AIMDurr
T6
SW40-01
SW20-G
SW20-6
SW20-3
SW20-N
SW20-M
SWE
SW20-H
SW20-9
SW20-T
SW20-7
SW10-C
SW20-R
SW10-D
SW20-L
SW20-P
SW10-7
SW20-2
SW20-8
AIM6
SWA
SWB
7 AM
8 AM
9 AM
10 AM
11 AM
12 PM
1 PM
2 PM
3 PM
4 PM
5 PM


March 12, 2018 - Day - 05:28 PM
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
3/12 7:00
3/12 9:00
3/12 11:00
3/12 13:00
3/12 15:00
3/12 17:00

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

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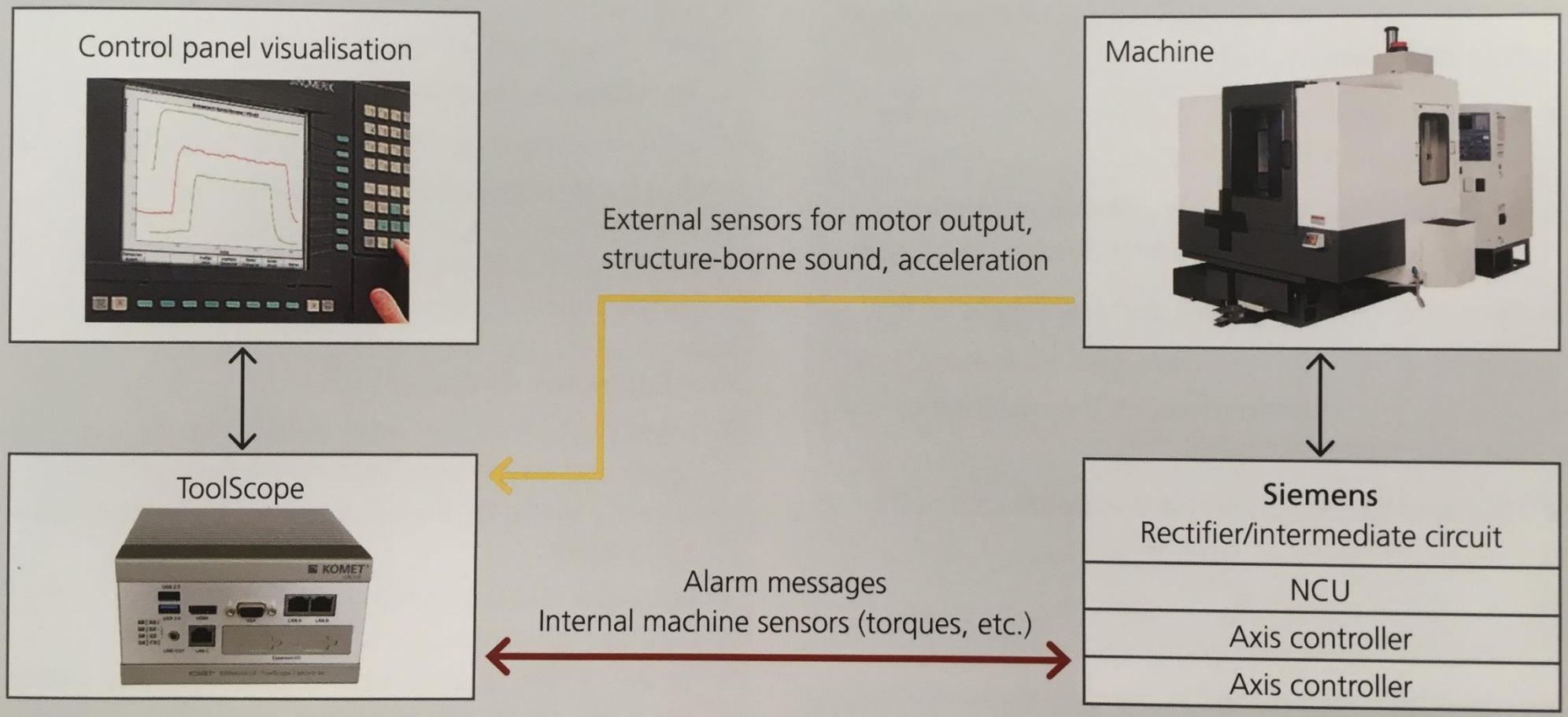
Integration of the system into the machine tool

Diagram showing integration



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

GENEDGE

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