

Manufacturing Analytics



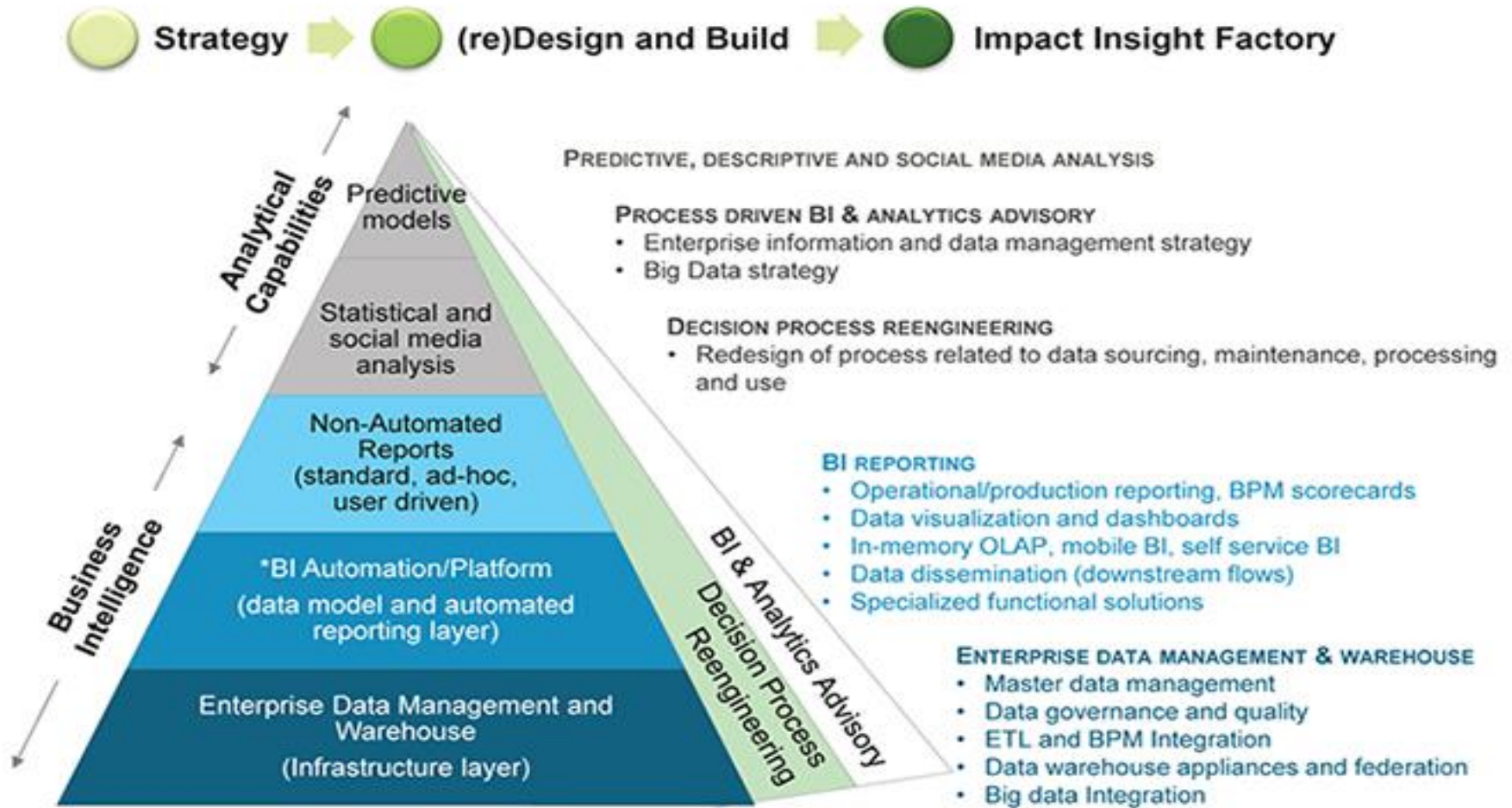
- Manufacturing Analytics Overview and Subject Areas
- Manufacturing Quality Analytics
 - FPY / RY / PY
 - DPMOs
 - Traceability RCA / Batch
 - Isochronal Charts
 - Measurement Data Analytics
 - Statistical Process Control
 - Exploratory Measurement Variables Analytics
 - Data Mining / Predictive Analytics of variables relations
- Field Quality Engineering Analytics
 - Warranty Analytics
 - Failure / Repair Analytics

Manufacturing Analytics Overview



Typical BI Lifecycle for Manufacturing

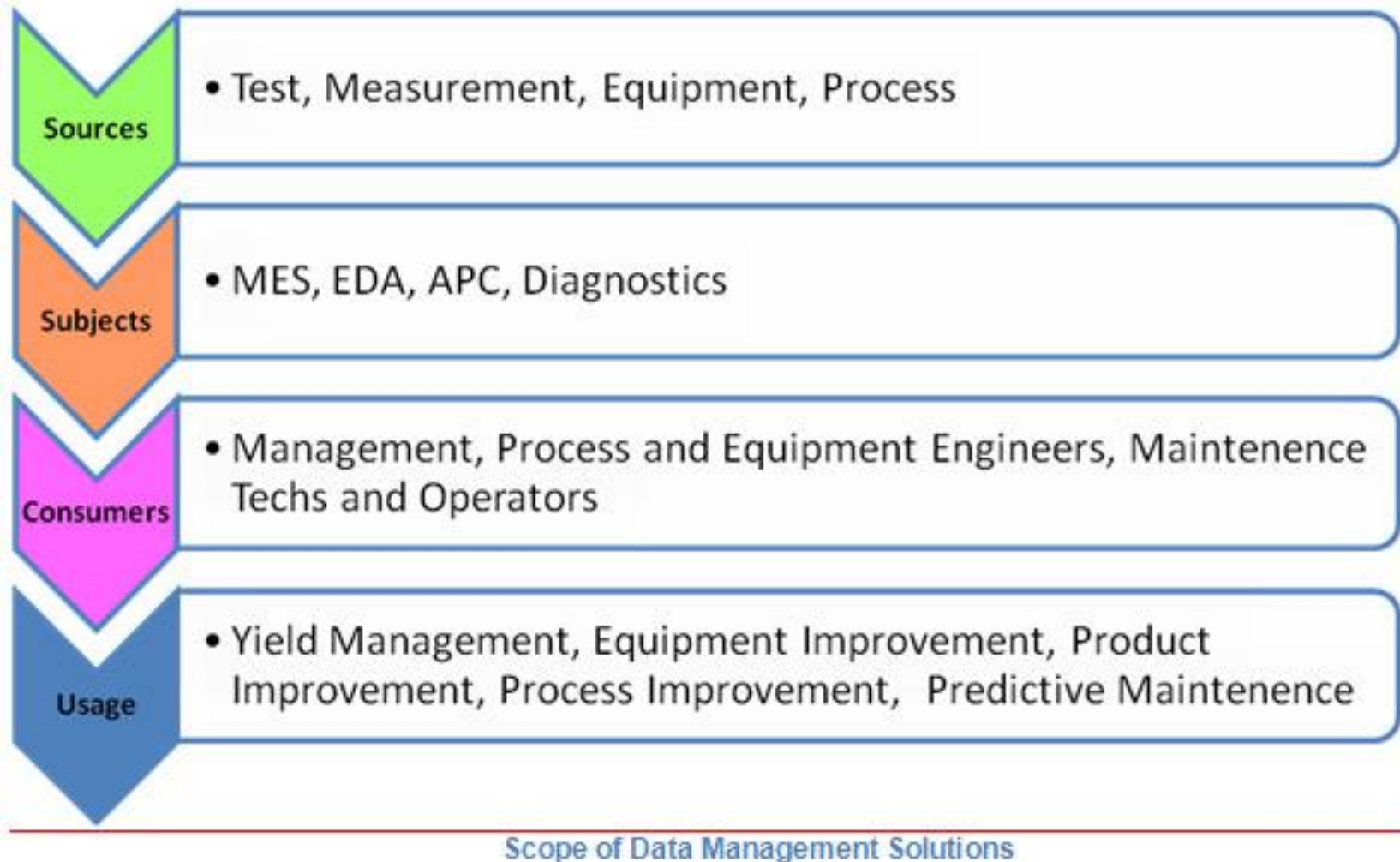
"Full –Stack" Business Intelligence solutions throughout the BI lifecycle



* Includes Self Service BI, OLAP – online analytical processing, BPM – business process management, ETL – extract, transform & load,

Figure 3. "Full –Stack" Business Intelligence solutions throughout the BI lifecycle

Scope of BI for Manufacturing

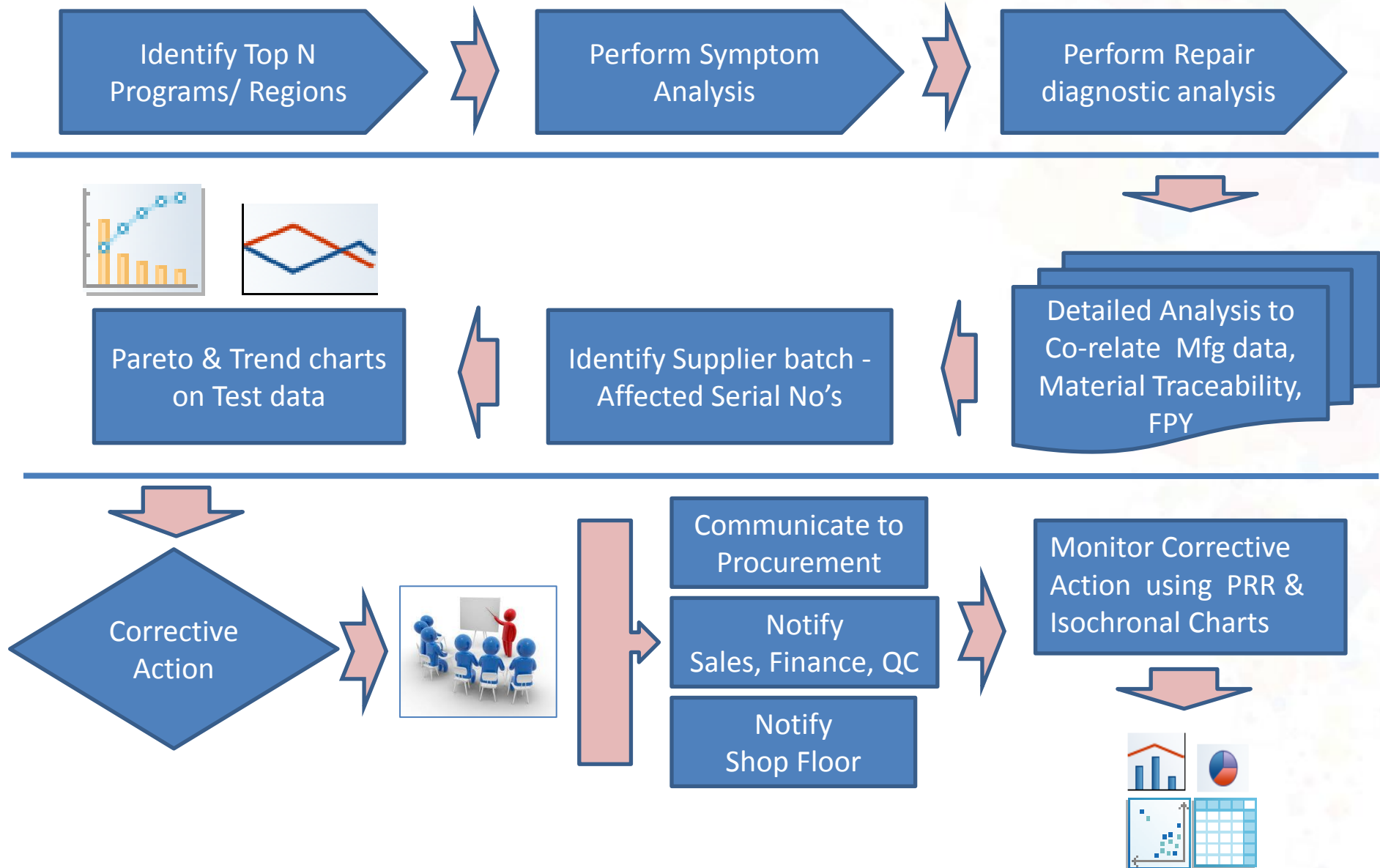


Production Analytics Overview



- First and foremost consideration for a manufacturing organization is zero defects / six sigma
- Manufacturing Quality and associated analytics first step to help:
 - Improve production quality
 - Reduce Field Warranty Costs
 - Minimize Field Failure and Returns
 - Improve Repair Process
 - Measurement Data Analytics for SPC
 - Improve Process Efficiencies
 - Trace the failure to production to shipping path and identify root cause for failures

Sample Story Board Theme: Warranty Cost Reduction



- Order Delivery Time
- Suppliers and Material Movement (backflush)
- Capacity Utilization
- Inventory Carrying Costs
- Variances above or below safety stock
- Efficiency of resources / equipments
- Plan vs. Actuals
 - Quantity Adherence
 - Hours worked
 - Material / Waste reduction
- Root cause analysis

- Material Costs
 - Standard
 - Actual
 - Variance
- Resources Costs
 - Standard
 - Actual
 - Variance
- Overheads
 - Standard
 - Actual
 - Variance
- All cost variances / trends M-o-M, Q-o-Q, Y-o-Y etc.

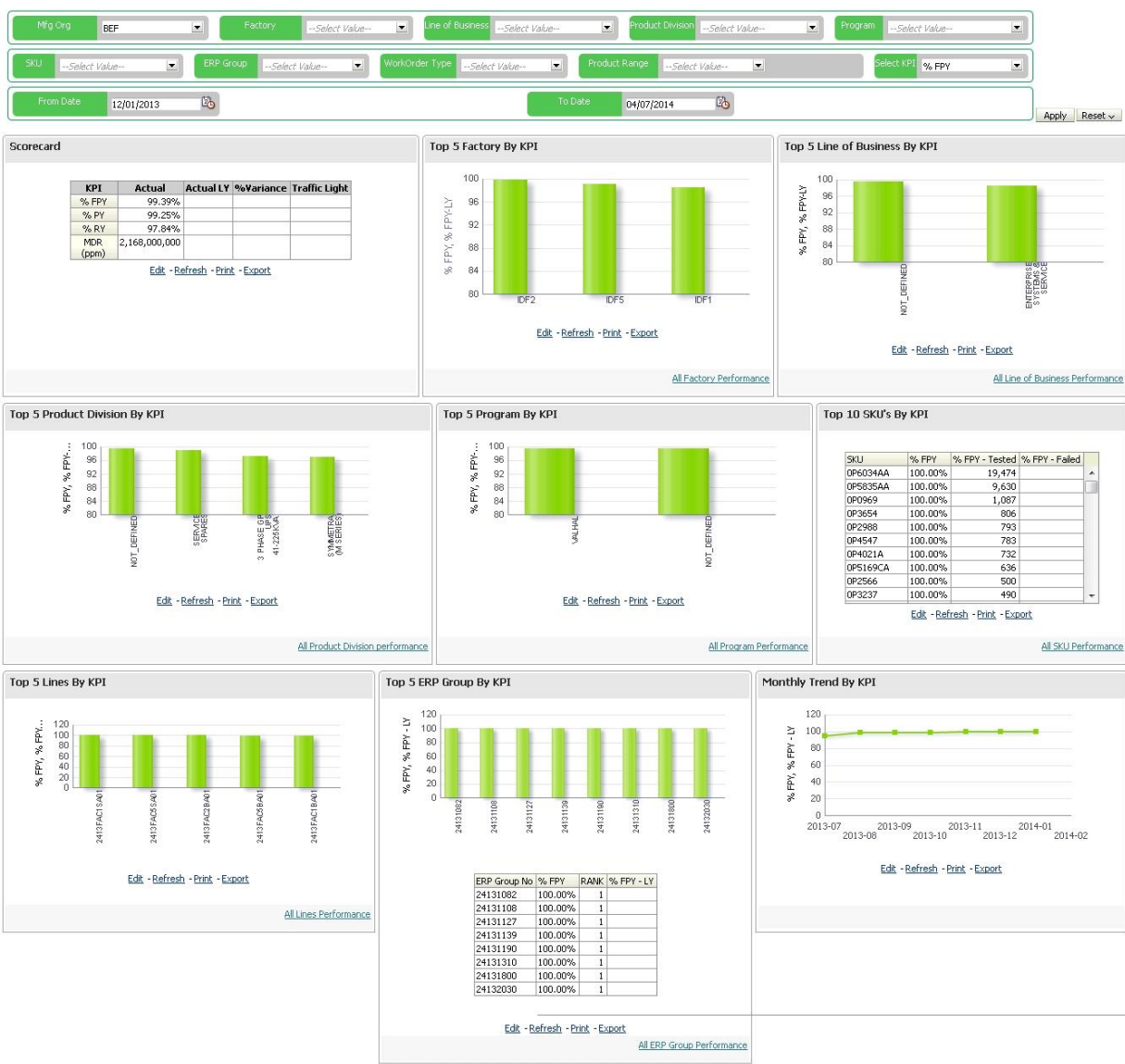
- Quantity
 - Available
 - In transit
- Amount
 - Available
 - In transit
- Work in Progress Inventory
 - Quantity
 - Amount
- Critical Components
 - Container number
 - Station
 - Time of availability
- Just in Time Inventory (shop floor)

Manufacturing Quality Analytics



- Manufacturing Quality Analytics
 - FPY / RY / PY
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Manufacturing Quality – FPY / MDR Analysis



Manufacturing Quality – FPY Analysis vs. Target



Mfg Org: PIF Factory: --Select Value-- Line: --Select Value-- ERP Group: --Select Value-- Station: --Select Value--

Line of Business: --Select Value-- Product Division: --Select Value-- Program: --Select Value-- SKU: --Select Value-- WorkOrder Type: --Select Value--

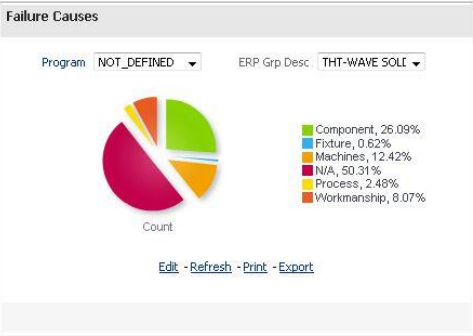
From Date: 12/01/2013 To Date: 12/31/2013

Apply Reset

Table

| Program | ERP Group Desc | LY-YTD | M8 | M9 | M10 | M11 | M12 |
|--------------|------------------------------------|--------|--------|----|---------|---------|---------|
| | TST-FINAL TEST | | | | | 96.15% | 96.33% |
| | TST-IN CIRCUIT - SECOND STAGE TEST | | | | | 0.00% | 0.00% |
| | TST-IN CIRCUIT TEST | | | | | 0.00% | 0.00% |
| AMAROK 1 | TST-AQL DISCHARGE TEST | | | | | 100.00% | 100.00% |
| | TST-ELECTRICAL SAFETY TEST | | 98.43% | | | 99.34% | 99.34% |
| | TST-FINAL TEST | | 96.11% | | | 95.03% | 95.03% |
| ATS REVISION | TST-ELECTRICAL SAFETY TEST | | | | 100.00% | 100.00% | 100.00% |
| DELL REUNION | TST-AQL DISCHARGE TEST | | | | | 99.04% | 99.04% |
| | TST-ELECTRICAL SAFETY TEST | | | | | 98.40% | 98.40% |
| | TST-FINAL TEST | | | | | 94.00% | 94.00% |
| EQUINOX 1 | TST-ELECTRICAL SAFETY TEST | | | | | 100.00% | 100.00% |

Edit - Refresh - Print - Export



Top 10 Failure Type

Program: NOT_DEFINED ERP Group Desc: THT-WAVE SOLT

| Failure Type Desc | Count | Contribution |
|----------------------|-------|--------------|
| INT-Defective | 48 | 2.00% |
| RES-Missing | 21 | 0.00% |
| SOL-No solder | 13 | 0.00% |
| CON-Lifted | 8 | 0.00% |
| INT-Lifted | 8 | 0.00% |
| CAP-Reversed | 6 | 0.00% |
| IND-Out of Tolerance | 6 | 0.00% |
| CAP-Defective | 5 | 0.00% |
| REL-Lifted | 5 | 0.00% |
| CNT-Broken | 4 | 0.00% |

Edit - Refresh - Print - Export

Failure Type - Detail Analysis

Top 10 Failure Image

Program: NOT_DEFINED ERP Group Desc: THT-WAVE SOLT

| Failure Image Desc | Count | Contribution |
|--------------------|-------|--------------|
| | 161 | 7.00% |

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Failure Image - Detail Analysis

Station Contribution

Program: NOT_DEFINED ERP Group Desc: THT-WAVE SOLT

| Station | Line | Count | Contribution |
|----------------|--------------|-------|--------------|
| 01291080THD101 | 0129FAD1BA05 | 87 | 3.00% |
| 01291080THC301 | 0129FAC3BA01 | 74 | 3.00% |

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Station Contribution - Detail Analysis

Bottom 10 SKU's

Program: 03-72-132386-0 ERP Group Desc: FAS-UNIT BUILD

| SKU | % FPY | Tested | Failed |
|----------|--------|--------|--------|
| 0P5270AA | 50.00% | 68 | 34 |
| 0P5271AA | 50.00% | 38 | 19 |
| 0P1305-Z | 64.71% | 17 | 6 |
| 0P5272-Z | 69.81% | 106 | 32 |
| 0P3928 | 69.83% | 179 | 54 |
| 0P2994AF | 72.69% | 227 | 62 |
| 0P4532 | 73.81% | 126 | 33 |
| 0P5745 | 75.68% | 74 | 18 |
| 0P2990AF | 76.74% | 619 | 144 |
| 0P2996AF | 78.14% | 485 | 106 |

Edit - Refresh - Print - Export

All SKU Performance

Reference Designator

Program: NOT_DEFINED ERP Group Desc: THT-WAVE SOLT

| Ref Designator | Count |
|----------------|-------|
| R951-327470-1 | 21 |
| TMP-1420262-1 | 21 |
| J710A-678274-1 | 10 |
| J702A-678274-1 | 9 |
| C906-354826-1 | 8 |
| J2-746231-1 | 8 |
| TMP-1420264-1 | 8 |

Edit - Refresh - Print - Export

All Reference Designator

Manufacturing Quality – DPMO (i)

Mfg Org

--Select Value--

Line of Business

--Select Value--

Product Division

--Select Value--

WorkOrder Type

--Select Value--

From Date

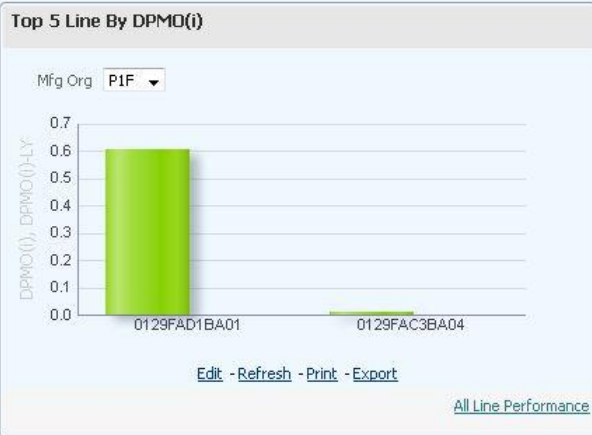
12/01/2013

To Date

12/31/2013

Apply

Reset



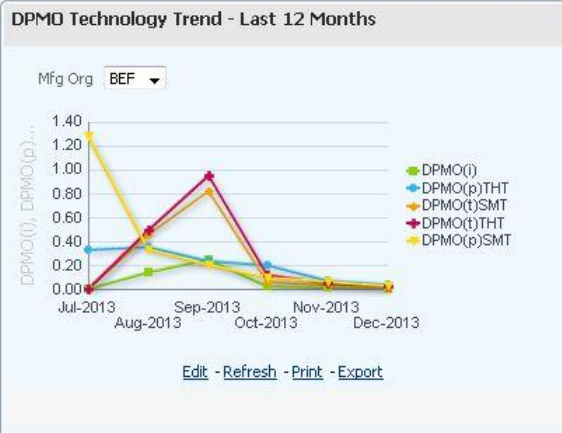
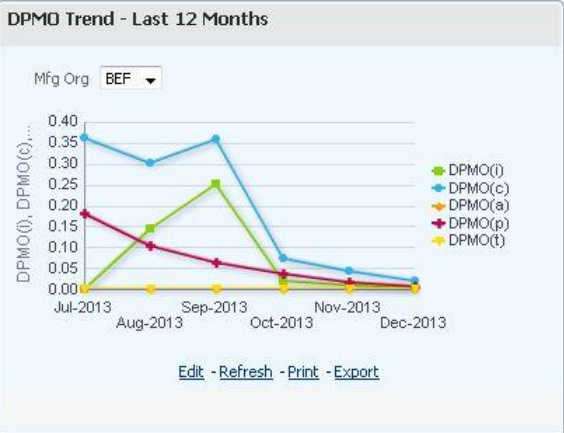
Bottom 10 SKU's

Mfg Org BEF

| SKU | DPMO(i) | DPMO(p)SMT | DPMO(p)THT | DPMO(t)SMT | DPMO(t)THT |
|----------|---------|------------|------------|------------|------------|
| 0P0317A | 0.00 | | 0.00 | | 0.00 |
| 0P0392 | 0.00 | | 0.00 | | 0.00 |
| 0P0467-Z | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0P0500-Z | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0P0531-Z | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0P0969 | 0.00 | | 0.00 | | 0.00 |
| 0P0970 | 0.00 | | 0.00 | | 0.00 |
| 0P1934A | 0.00 | 0.58 | 0.64 | 0.00 | 0.00 |
| 0P2340A | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0P2342 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0P2354B | 0.00 | 0.00 | | 0.00 | 0.00 |

Edit - Refresh - Print - Export

All SKU Performance



Manufacturing Quality – DPMO (p)



Mfg Org

Factory

Line

ERP Group

Station

Line of Business

Product Division

Program

SKU

From Date

To Date

Apply

Reset

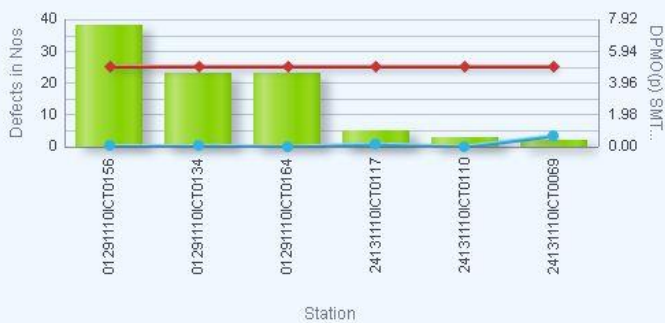
Top 10 SKUs Build Qty vs. DPMO(p) SMT Pareto



[Edit](#) - [Refresh](#) - [Print](#) - [Export](#)

[All SKU Performance](#)

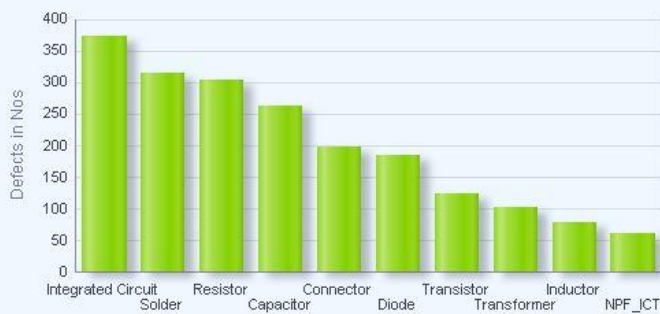
Top 10 Stations by # of Defects



[Edit](#) - [Refresh](#) - [Print](#) - [Export](#)

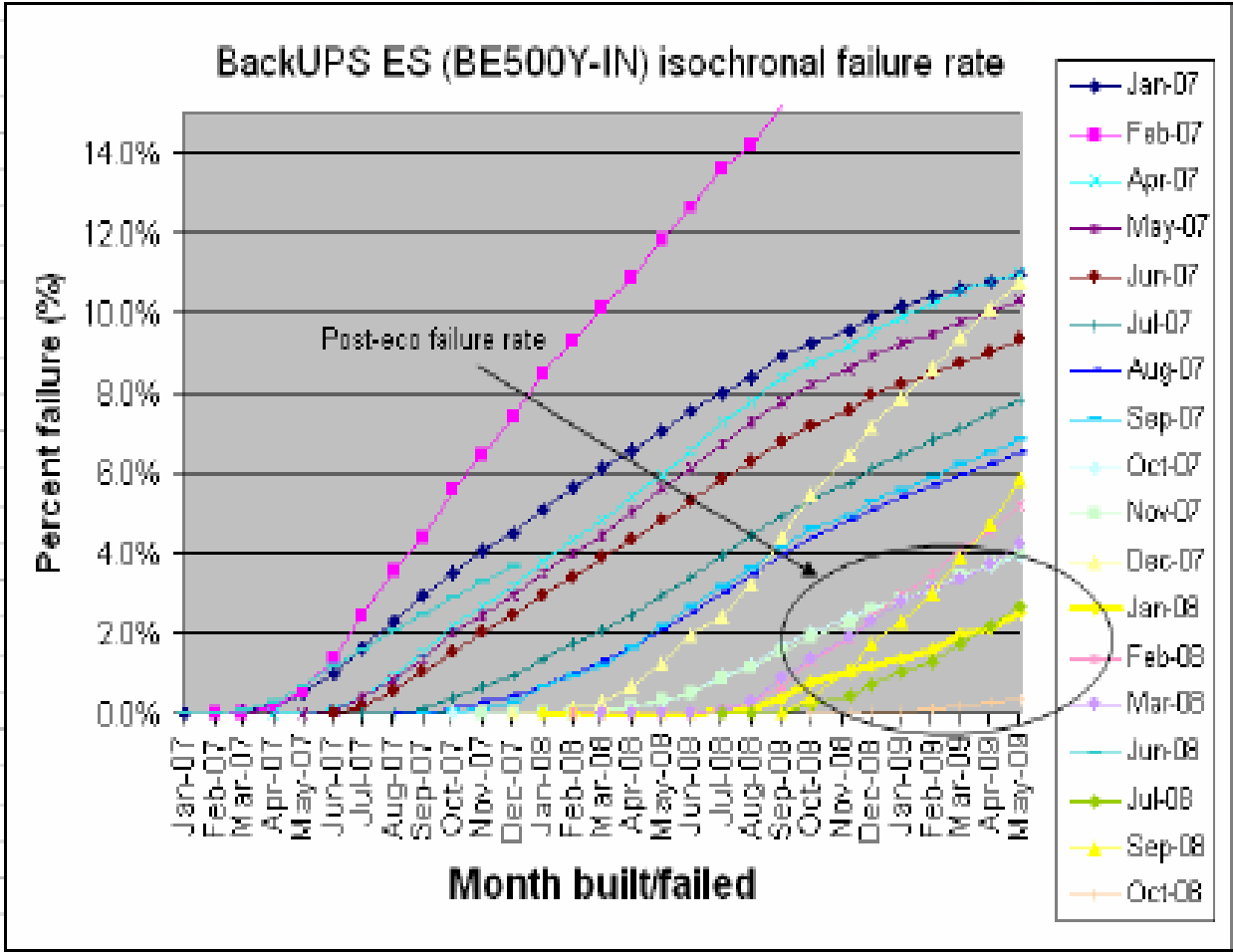
[All Station Performance](#)

of Failures by Failure Type



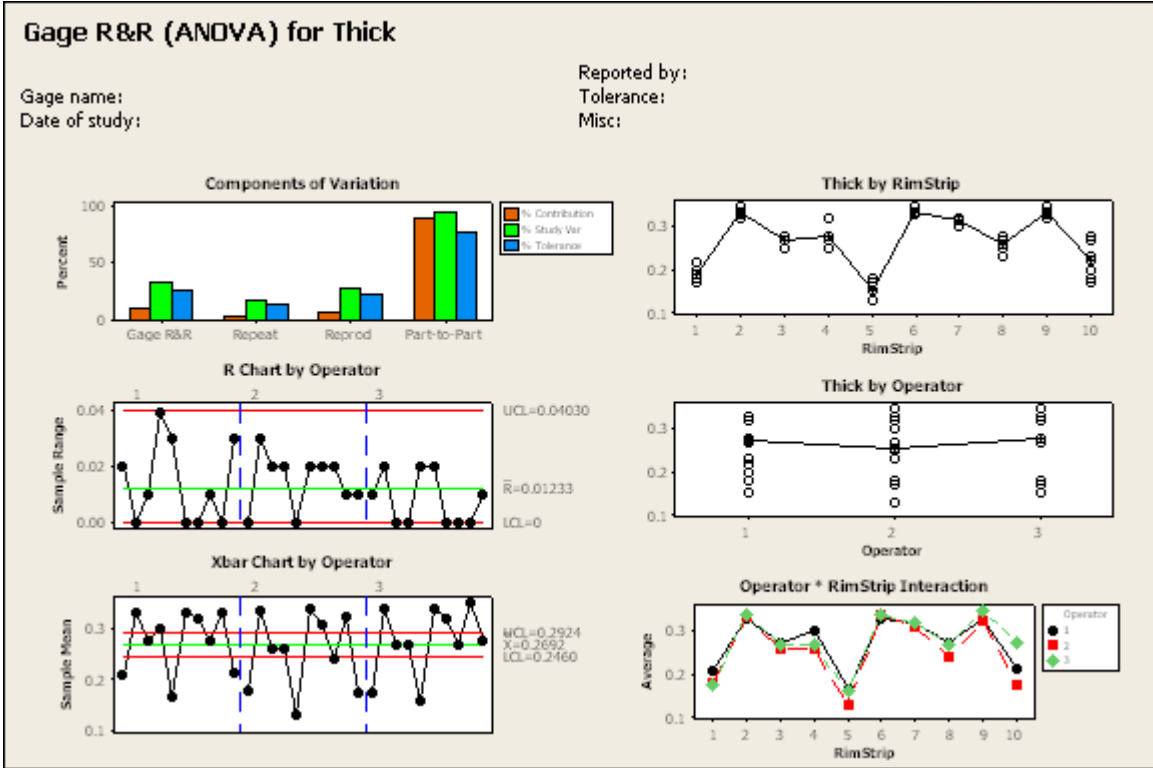
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[All Failure Type Analysis](#)

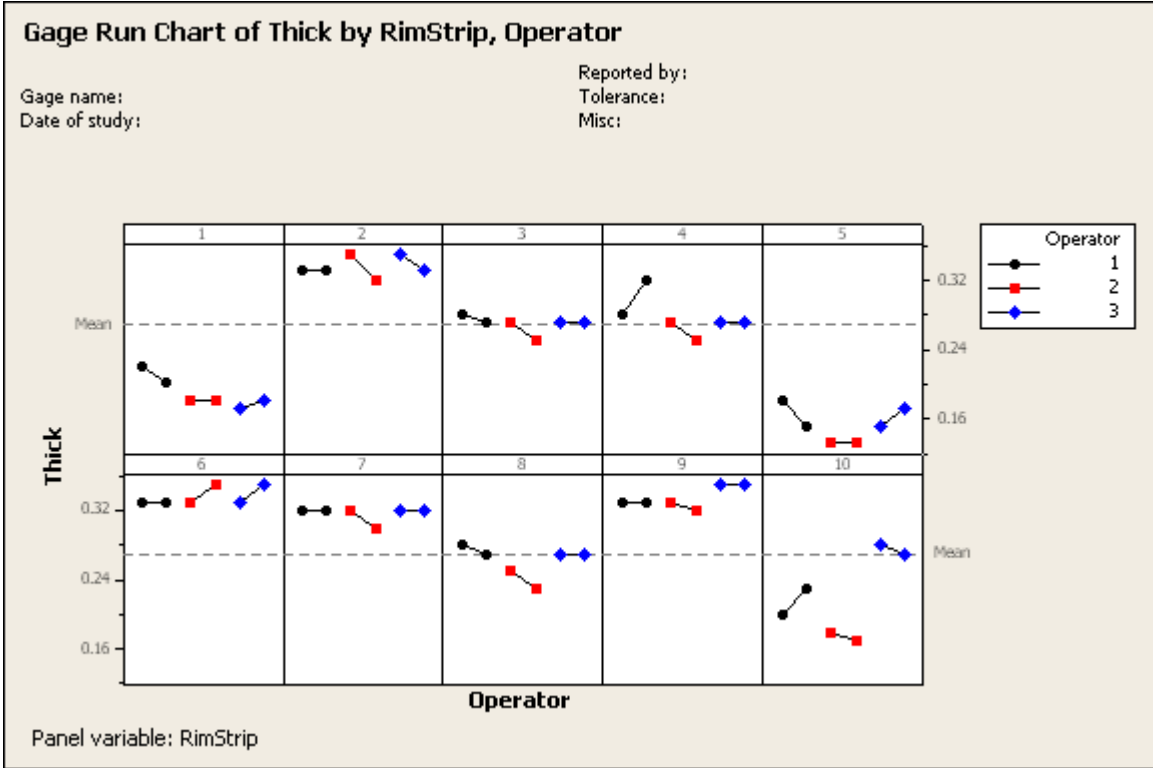


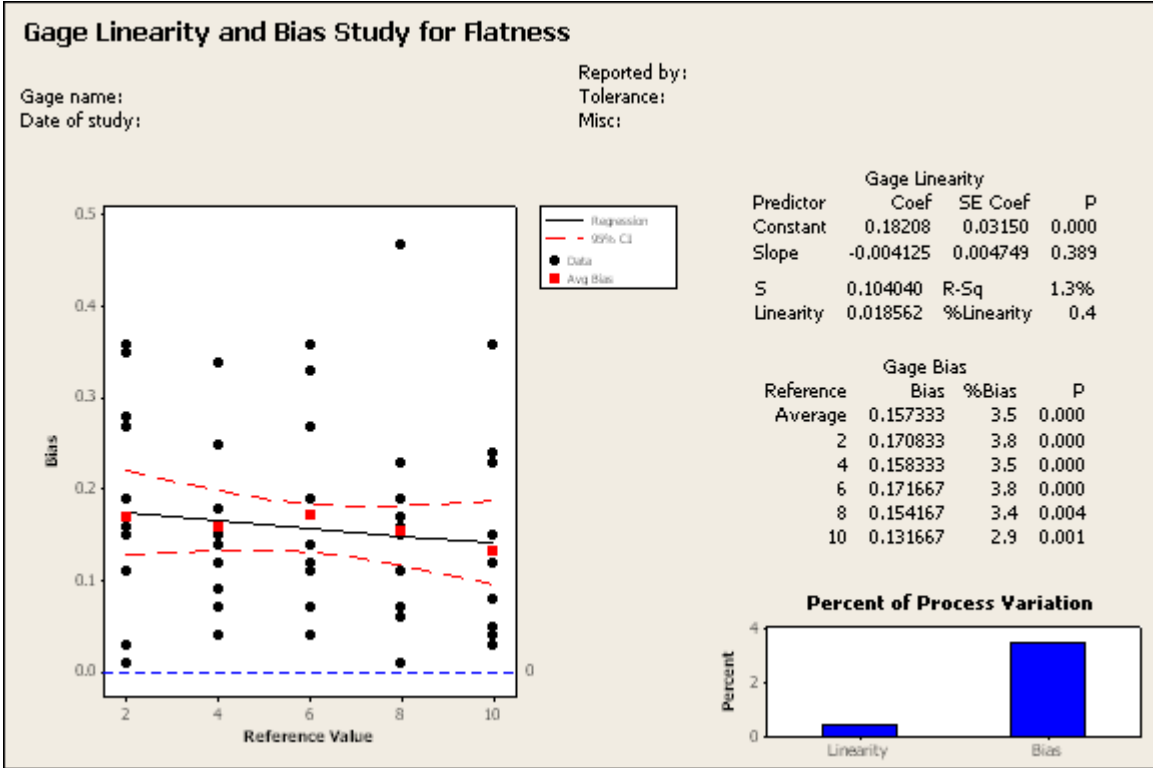
Manufacturing Measurement Analytics



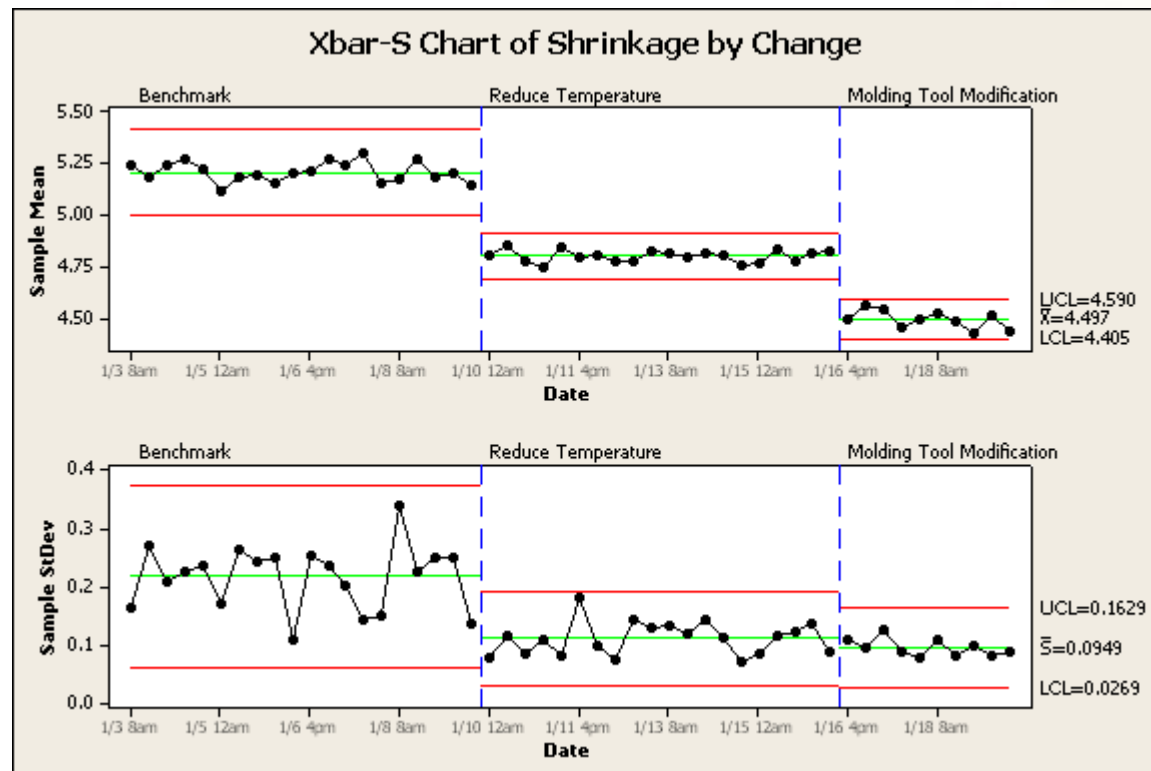


Measurement System Analysis – Gage Run

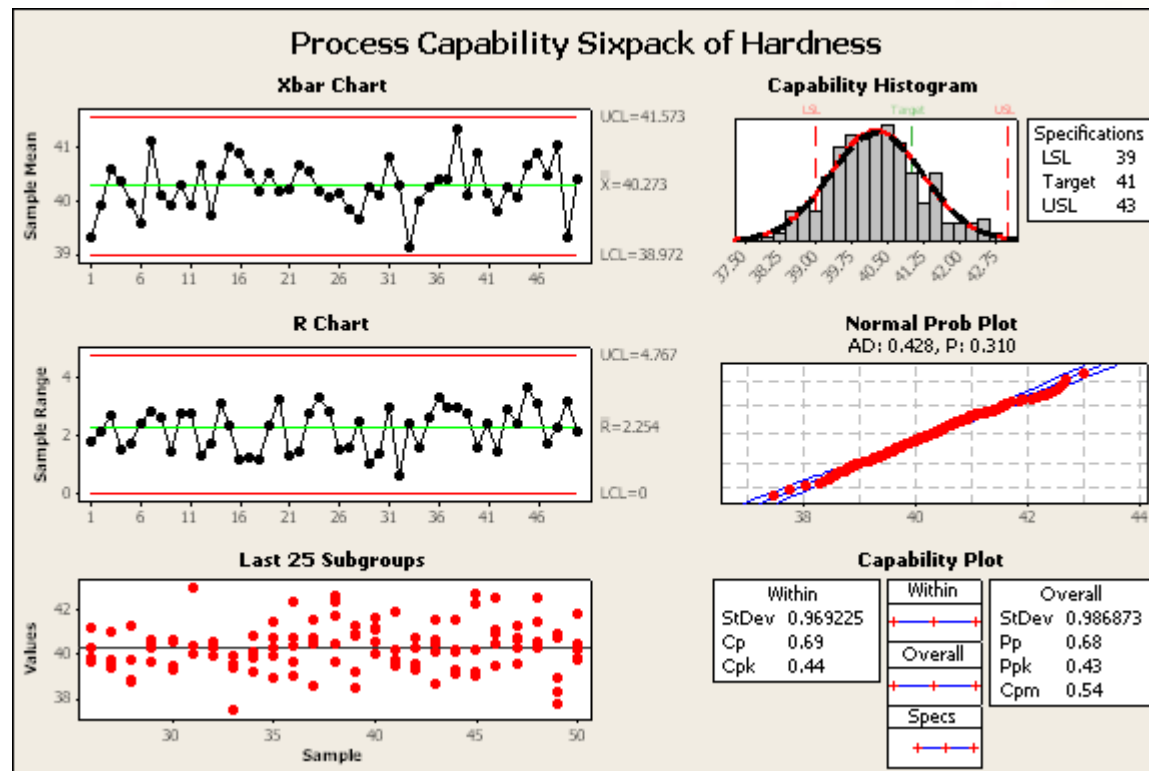




Control Charts - SPC



Capability Analysis – Six-Pack

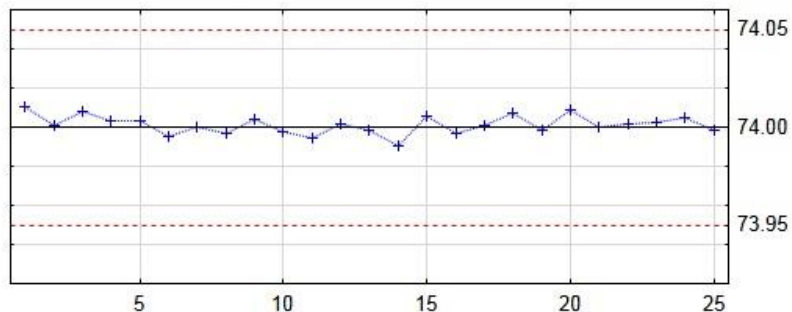


Statistical Process Control

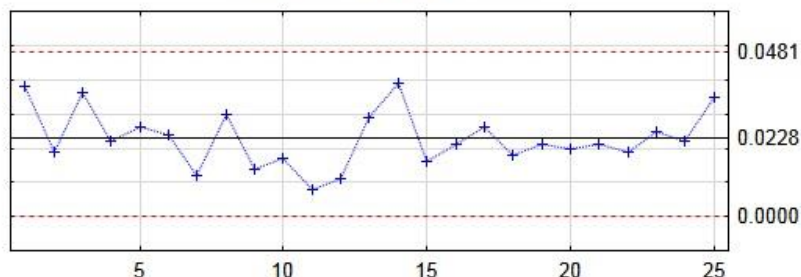
Summary for Variable: SIZE

Time dependent model:D Cp (QCS):1.5873 Cpk (QCS):1.4974

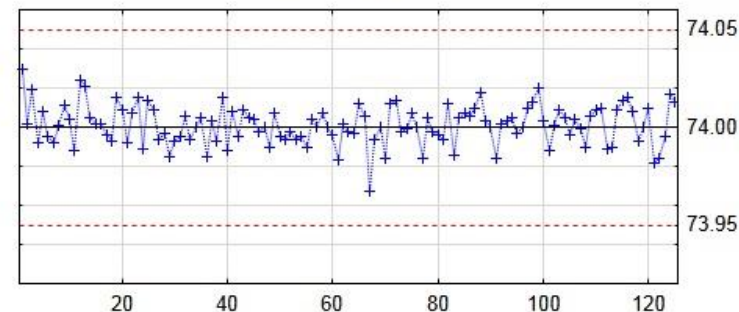
X-bar: 74.0000; Sigma :0.0101; n:5.00



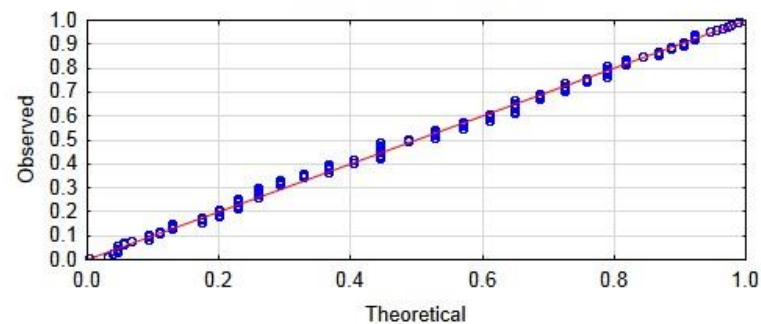
Range: 0.0228; Sigma :0.0085; n:5.00



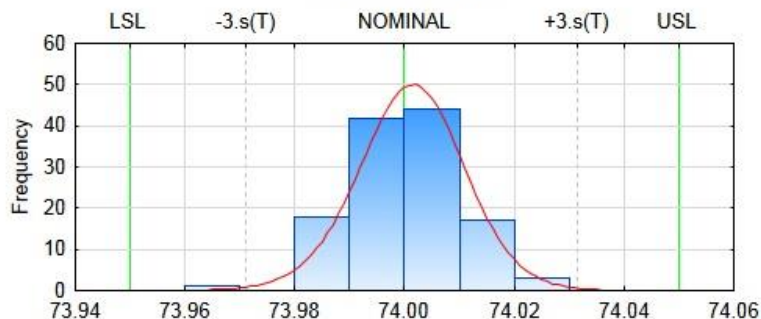
Individual plot



Probability Probability Plot



Capability Histogram



| | | | |
|------------------------|----------|-----------------------|-----------|
| Time dependent model | D | Mean | 74 |
| Cp (QCS) | 1.587 | Standard Deviation | 0.01007 |
| Cpk (QCS) | 1.497 | Variance | 0.0001014 |
| Outcoming distribution | Normal | Skewness | -0.09795 |
| Computational method | M1 (4,5) | Kurtosis | 0.4465 |
| LSL | 73.95 | Minimum Value | 73.97 |
| USL | 74.05 | Maximum Value | 74.03 |
| NOMINAL | 74 | Median | 74 |
| | | 25th Percentile (Q25) | 73.99 |
| | | 75th Percentile (Q75) | 74.01 |
| | | Number of samples | 25 |
| | | Average sample size | 5 |
| | | Sigma-S (R-bar/d2) | 0.009785 |

- Concurrent and near real-time monitoring
 - Pareto for symptoms, defects and repairs
 - FPY / RY / PY and UPH monitoring
 - Alerts rules and mails
- Exploratory data analysis / data discovery – measurement variables selections for:
 - Scatter/matrix plot analysis
 - Contour/3D scatter plot
 - Run charts and moving averages of freely definable length
 - Box plot
- Data mining / predictive analysis
 - Connections between process variable data and measurement data
 - Connections between process variable data and defect/repair data

Field Quality Engineering - As in Demo



Summary – possible next steps to MES Analytics

- Isochronal Charts / Analysis
- Measurement Data Statistical Analysis
- Measurement Data Advanced Analytics
- Measurement Data – Data Mining
- Real-time monitoring and alerting
- Other Manufacturing Subject Area Analytics:
 - Planning Adherence
 - Production Cost
 - Inventory

Thank You

