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Customer Success Is Our Mission

Automatic defect searching and categorization, method and application

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Automatic defect searching and categorization - Background

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- In the area of manufacturing, testing is done to assure form, fit and function of the units being produced
- Each unit that is tested has many associated measurements
- Reviewing these individual measurements over time is the basis for all SPC/Quality monitoring protocols
- If instead we treat each test as a basket of measurements we can compare baskets against one another

Each test produces n# of measurements

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Automatic defect searching and categorization – Value Proposition

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- If we can draw the link between the character of a unit produced and it's unique test measurement pattern we can group units with similar performance characteristics together automatically
- Units with specific problem types will cluster together
- In a factory where re-work is a significant cost driver, automation to identify a problem type and therefore drive to solution faster is a cost reduction opportunity

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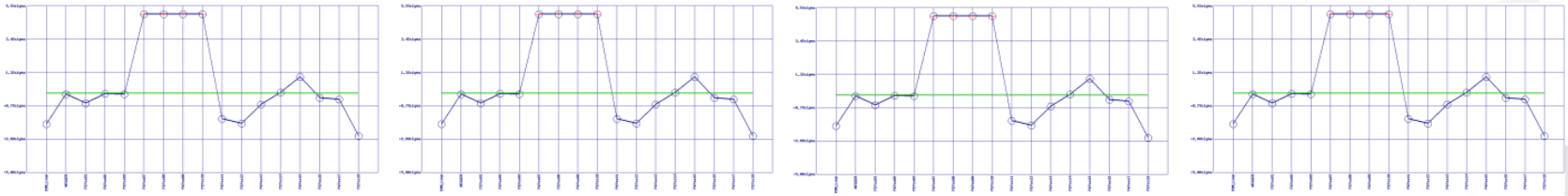
Matching units can be fixed the same way

How to find ‘like’ tests – First try

Using only a basic Pearson correlation coefficient couldn’t differentiate tests of the same type well

$$r_{xy} = \frac{\sum x_i y_i - n\bar{x}\bar{y}}{(n-1)s_x s_y} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2}\,\sqrt{n\sum y_i^2 - (\sum y_i)^2}}.$$

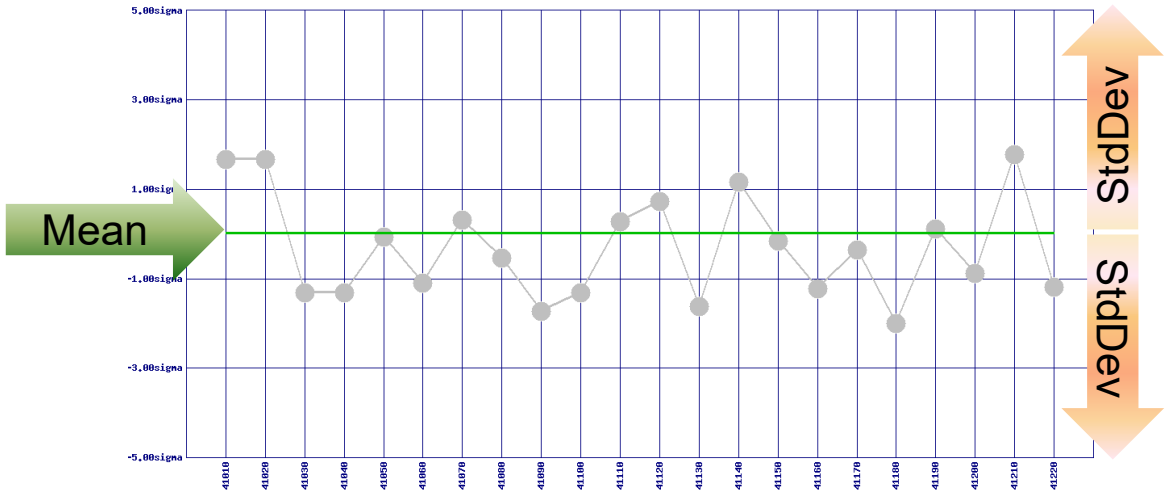
Individual measurements tend to operate in controlled ranges therefore tests of a particular type tend to have high correlation



Individual measurements tend towards control

How to find ‘like’ tests using history

- Using historical performance, each measurement can be normalized around its mean



- Each measurement varies from the mean by its standard deviation
- Therefore normal operating ranges with extreme values don’t bias the correlation

Correlating normalized values differentiates tests

A Tool to Compare Tests

Partition

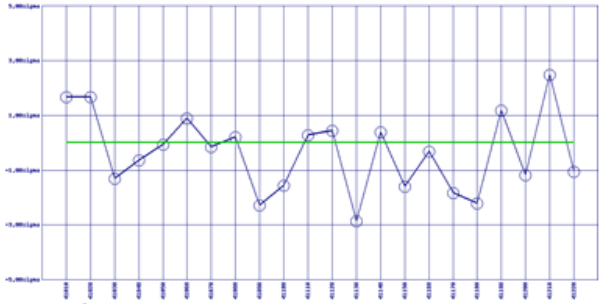
- [ ] 0 - All
- [ ] 1 - Automatic Pitch/Roll Final Balance
- [ ] 28 - Filterwheel
- [ ] 27 - NIFOV
- [ ] 11 - OLD NIFOV
- [ ] 12 - OLD Pitch Slope
- [ ] 9 - Pitch/Roll Unbalance
- [x] 59 - UGB Automatic Pitch/Roll Final Balance
- [ ] 60 - UGB Automatic Pitch/Roll Initial Balance
- [ ] 3 - Void

sort by: ID | name

Search for MSN or [x] Show Latest Units

6127

Test **FAIL** at **20140812:075218**



Legend:
- **Base pCode Value**
- **Comparison pCode Value**
- **Missing pCode Value**
- **pCode Value outside 5 sigma**

Show Data

Show 50

Search: fail

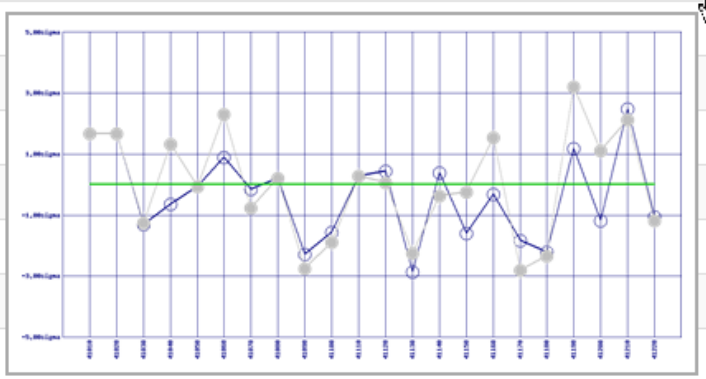
Row	TestStartTime	Serial Number	Result	Base pCode Count	Correlation	pCodes in This Test	DRAGON Data	Compare	SPC Notes	PRISM Data
1	20140812:075218	6127	FAIL	22	1.0	22			N/A	
2	20140812:074947	6127	FAIL	22	0.9907	22			N/A	
3	20140806:122453	6127	FAIL	22	0.9286	22			N/A	
4	20140806:120212	6127	FAIL	22	0.9163	22			N/A	
14	20140617:093623	6085	FAIL	22	0.8219	22			N/A	

Tool can search for failures of the same kind

Compare tests with high correlation

Show 50 Search: fail

Row	TestStartTime	Serial Number	Result	Base pCode Count	Correlation	pCodes in This Test	DRAGON Data	Compare	SPC Notes	PRISM Data
1	20140812:075218	6127	FAIL	22	1.0	22			N/A	
2	20140812:074947	6127	FAIL	22	0.9907	22			N/A	
3	20140806:122453	6127	FAIL	22	0.9286	22			N/A	
4	20140806:120212	6127	FAIL	22	0.9163	22			N/A	
14	20140617:093623	6085	FAIL	22	0.8219	22			N/A	
15	20130709:162250	5742	FAIL						N/A	
20	20111108:065636	05212	FAIL						N/A	
21	20140807:190415	6127	FAIL						N/A	
25	20140807:204457	6127	FAIL						N/A	
29	20140807:184529	6127	FAIL						N/A	
31	20131217:040842	5900	FAIL						N/A	
36	20140812:085546	6128	FAIL						N/A	
54	20140812:085932	6128	FAIL	22	0.7332	22			N/A	
67	20130709:162714	5742	FAIL	22	0.7204	22			N/A	



See how close one test matches another

Link to shop floor control system for answers

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childOpNum	childOpShortTxt	childObservedDate	childDefectCode	childDefectCodeGrp	childIncident	childPN	childSN
6510	TEST	06/17/2014 00:00:00	Indeterminate Failure	Test	CND_BAL TST_UNBALANCE_PITCH AXIS_NA	2212900-12	6085
6510	TEST	06/16/2014 00:00:00	Suspected Defective Component	Test	CNF_BALANCE TEST_YAW UNBALANCE ROLL	2212900-12	6085
6510	TEST	06/13/2014 00:00:00	Suspected Defective Component	Test	CNF_BALANCE TEST_YAW UNBALANCE ROLL	2212900-12	6085

06/13/2014 15:01:04
UUT fails Balance Verification p-code 41160 Yaw Unbalance about Roll
MEAS: 1.21 and 1.20 UL: 1.00 Gm-cm
Resolver CW is too heavy
RR Resolver Counterweight PN 2212938-1

Showing 1 to 3 of 3 entries Previous 1 Next

Now a user can look at history of similar units to determine corrective action

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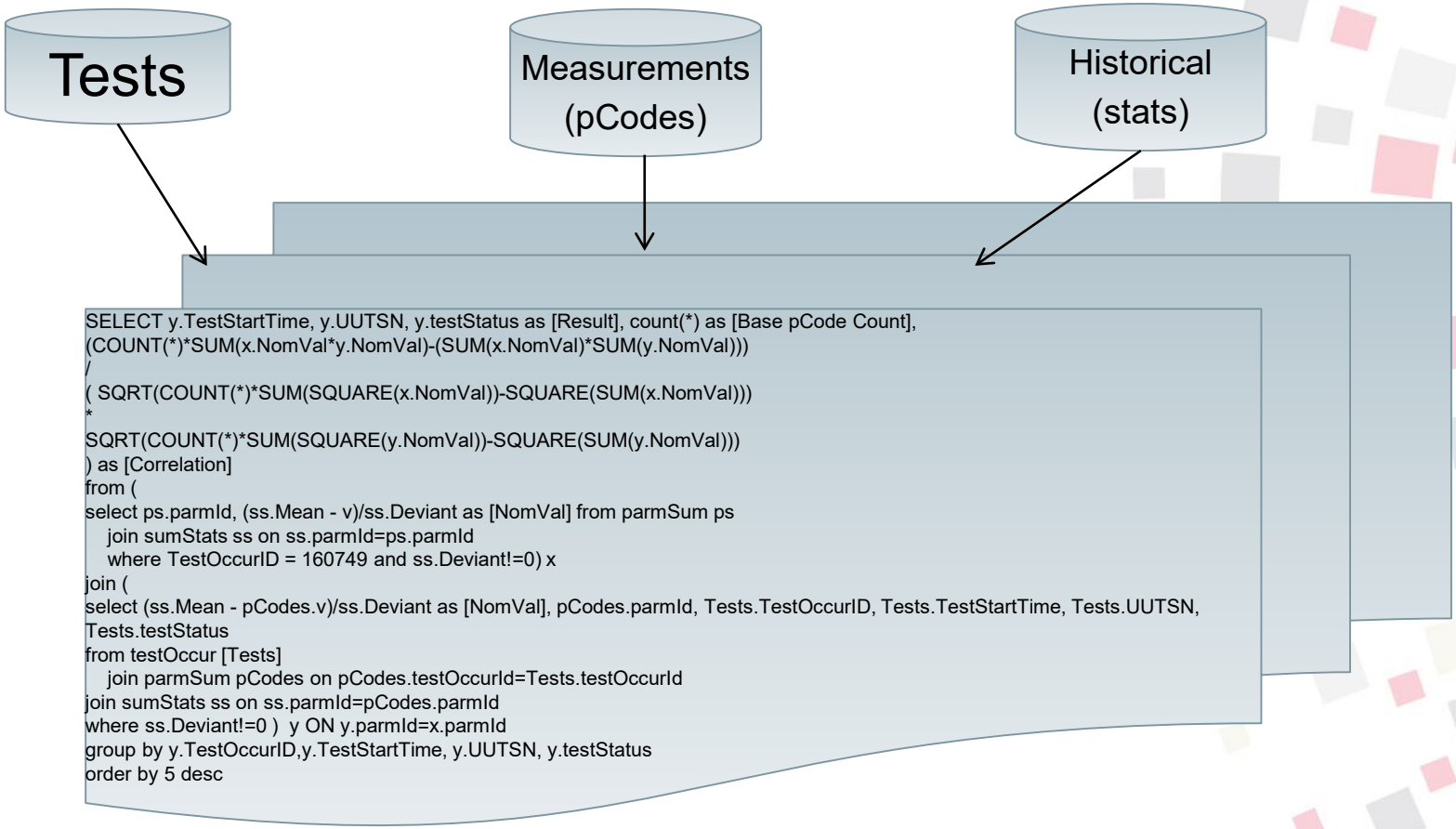
Not the first time a problem type has occurred

Normalized correlation in real time



Combining data at run time allows instant results

Tool must be fast to be useful