



Using Monte Carlo Simulation to establish the metric for yield improvement decision making

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Introduction

- I AM graduated from Tianjin University, and received a Master Degree in operation excellence on statistical field and double bachelor degree on EE/Computer science . Since then I have worked for P&G, Freescale(Previous Motorola SPS),NXP, Qorvo and joined Micron in Xian in 2017 in the areas of test engineering technology , operation statistics and management.
- I AM Freescale(Previous Motorola SPS) Six Sigma Black Belt, freescale/NXP global six sigma committee member, Project management professional certification by PMI and applied statistical trainer certified by SAS in Austin.TX, National Senior Engineering.



Charter

- Challenge For Semiconductor Industry
 - > Safety
 - > Quality
 - > Delivery(OTD etc.)
 - > Cost(Yield etc.)
- Application Metric with JMP enablement
 - > Business Case
 - > Monte Carlo Simulation
 - > How to perform in JMP Pro.



Challenge For Semiconductor Industry



Key Points:

- Deliver exceptional customer experiences by achieving operational efficiency and industry-leading technical leadership.
- Provide industry-leading innovation by partnering together to deliver high-value bits with world-class quality.

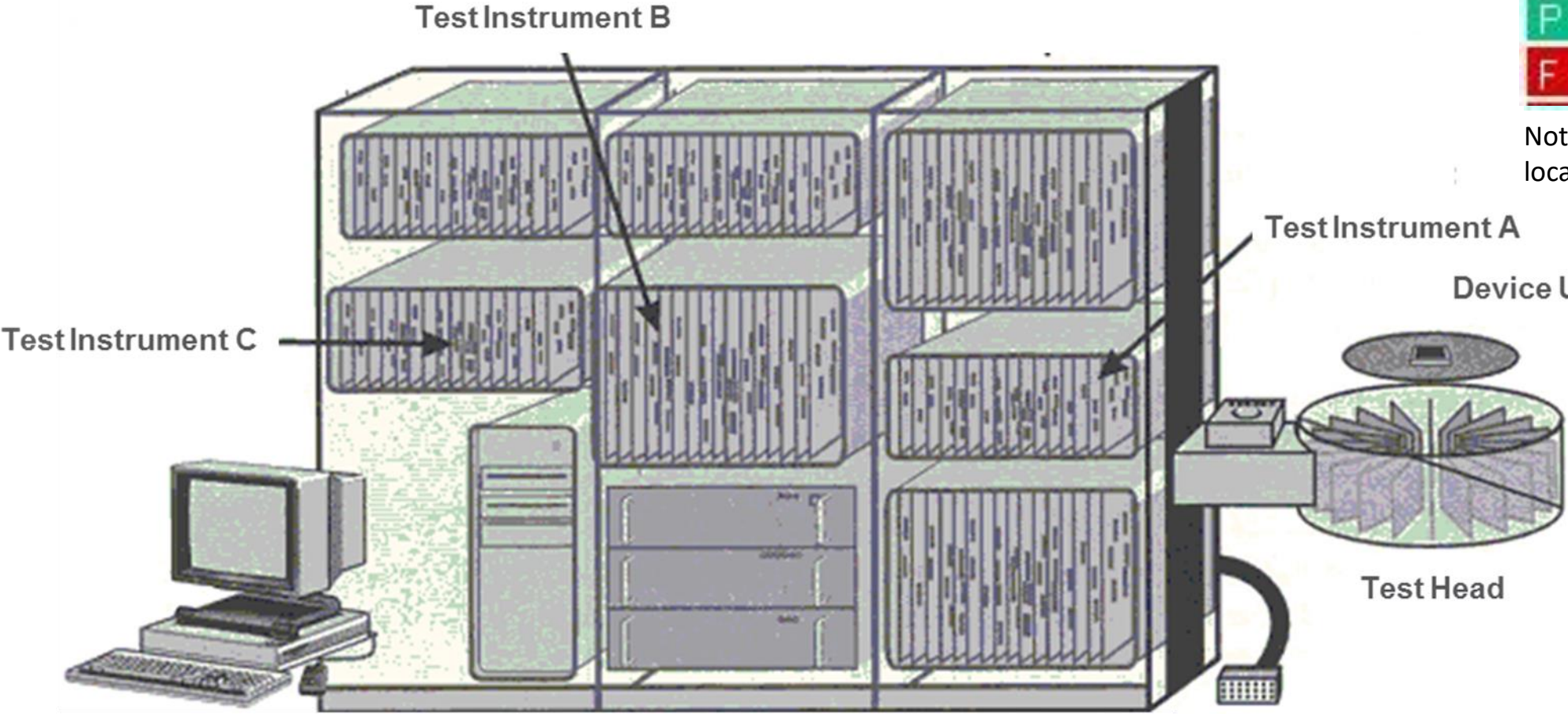
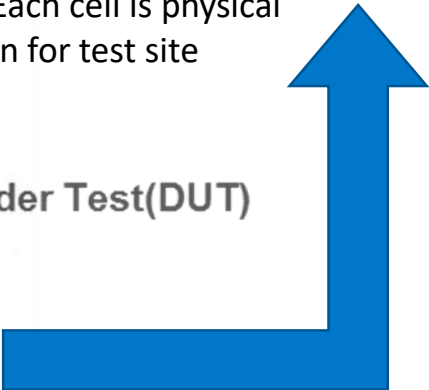
Business Case- Test Sites Disable

The valid question is when the maintenance team need to fix the test sites/down the machine and when the machine need to keep running due to man power constrain?

Test Sites Demo.
(Parallelism)

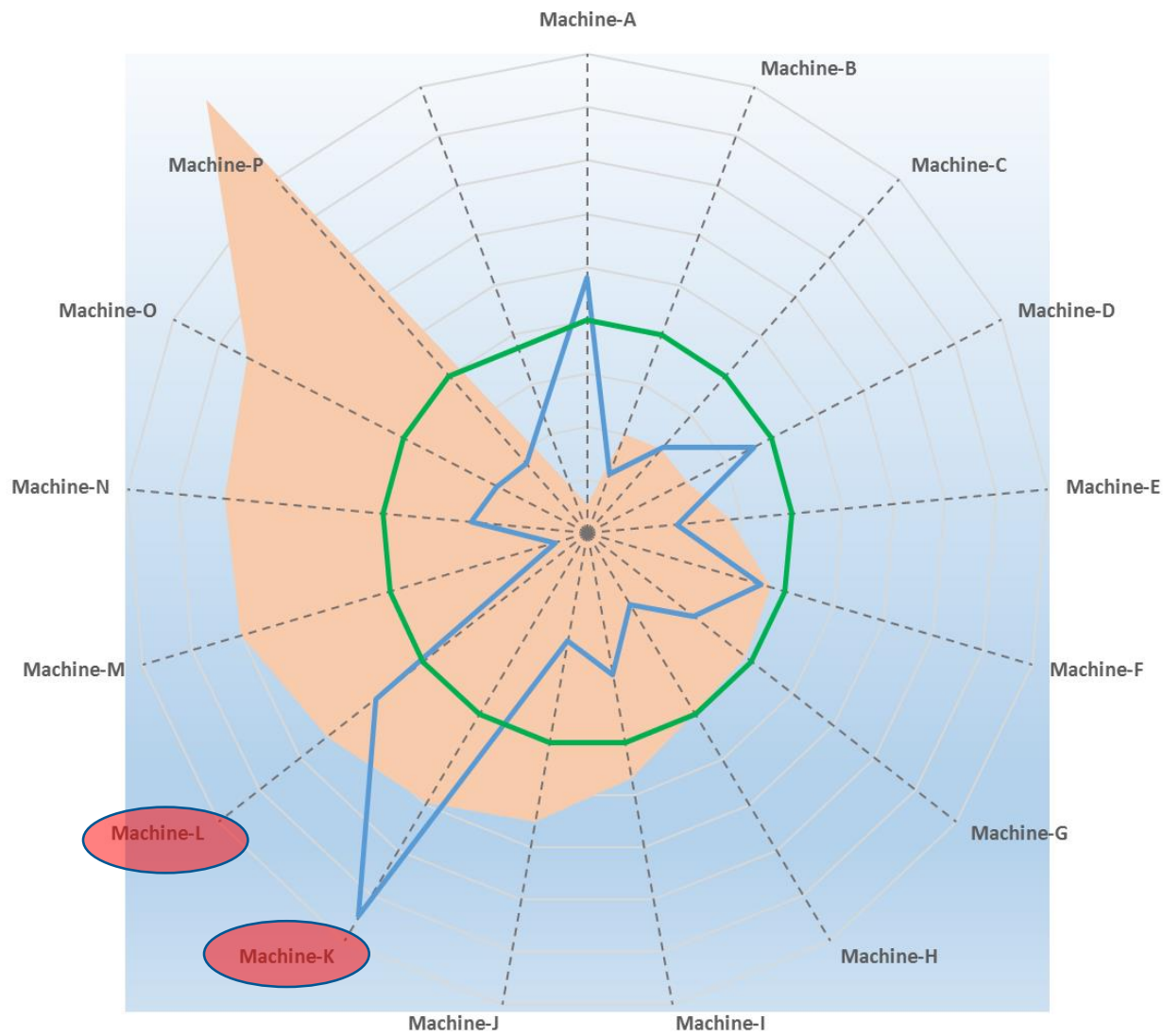


Note: Each cell is physical location for test site



IS(当前)

Loading Disable_Rate Criteria



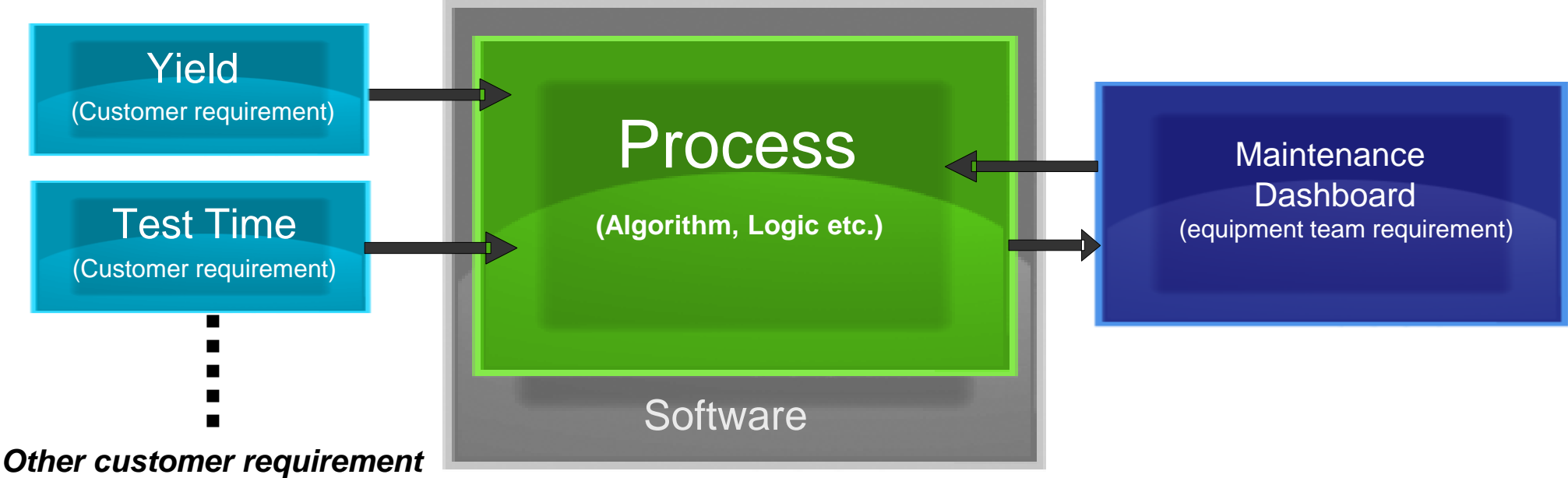
What's the model behind to support?

WAS(以前)

- 1) Fixed test sites disable quantity and then trigger maintenance
- 2) Apply the same test sites disable quantity to all the product.
- 3) No priority to handle the tasks if the rule is being triggered at the same period
- 4) No linkage to key product KPIs how good/bad is deserved to do maintenance.

Modeling concept and requirement

► Test Site Disable Maintenance Modeling



Model Selection

Modeling	Factors	Response	Variation
Simple Linear Regression	<i>Single</i>	<i>Single</i>	<i>Residual</i>
Multiple Regression	<i>Multiple</i>	<i>Single</i>	<i>Residual</i>
Monte Carlo Simulation	<i>Multiple</i>	<i>Multiple</i>	<i>Consider random for both inputs and response</i>

What's the Monte Carlo Simulation?

蒙特卡洛（Monte Carlo）方法，又称随机抽样或统计试验方法，属于计算数学的一个分支，它是在上世纪四十年代中期为了适应当时原子能事业的发展而发展起来的。传统的经验方法由于不能逼近真实的物理过程，很难得到满意的结果，而蒙特卡罗方法由于能够真实地模拟实际物理过程，故解决问题与实际非常符合，可以得到很圆满的结果。这也是以概率和统计理论方法为基础的一种计算方法，是使用随机数（或更常见的伪随机数）来解决很多计算问题的方法。将所求解的问题同一定的概率模型相联系，用电子计算机实现统计模拟或抽样，以获得问题的近似解。**为象征性地表明这一方法的概率统计特征，故借用赌城蒙特卡罗命名。**

蒙特卡洛是摩纳哥公国的一座城市，位于欧洲地中海之滨、法国的东南方，属于一个版图很小的国家摩纳哥公国，世人称之为“赌博之国”



How to perform Monte Carlo Simulation in JMP Pro.?

- This simulation can enable user to discover the distribution of model outputs as a function of the random variation in the factors. The simulation facility in the profiler provides a way to set up the random inputs and run the simulations, producing an output table of simulated values (For this case is site disable rate). In this Profiler, factor mean and std. deviation can be set below for each factor's profile. The simulation histogram is shown on the right for 'site disable rate' response. Then the user can set the each factor's mean and std. deviation to see how the 'site disable rate' mean value could be.
- Open user data in JMP, select Analyze > Fit Model, and fit a model with a continuous Y variable, there will be presented with a Least Squares report. Click the "hotspot" (little red triangle) in the top left of that report and choose Factor Profiling > Profiler. Now click the hotspot on the Profiler and choose Simulator.

Effect Summary

Source	LogWorth	PValue
Normal Yield	3.422	0.00038
Normal Yield*Retest TT per units(s)	3.356	0.00044
Retest TT per units(s)	3.252	0.00056
Normal_Disable_Rate*Normal TT per units(s)*Retest Yield*Retest TT per units(s)	1.771	0.01695
Normal TT per units(s)*Retest Yield	1.731	0.01856
Normal TT per units(s)*Retest Yield*Retest TT per units(s)	1.409	0.03902
Normal_Disable_Rate*Normal TT per units(s)*Retest Yield	1.187	0.06501
Retest Yield*Retest TT per units(s)	0.984	0.10365
Retest Yield	0.903	0.12509
Normal_Disable_Rate*Normal TT per units(s)	0.808	0.15577
Normal_Disable_Rate*Retest Yield*Retest TT per units(s)	0.798	0.15933
Normal_Yield*Normal TT per units(s)*Retest Yield*Retest TT per units(s)	0.787	0.16330
Normal_Yield*Retest Yield*Retest TT per units(s)	0.753	0.17647
Normal_Yield*Normal TT per units(s)*Retest Yield	0.730	0.18619
Normal_Yield*Retest Yield	0.727	0.18753
Normal_Disable_Rate*Retest Yield	0.688	0.20521
Normal_Yield*Normal_Disable_Rate*Normal TT per units(s)*Retest TT per units(s)	0.683	0.20771
Normal TT per units(s)*Retest TT per units(s)	0.669	0.21445
Normal_Yield*Normal_Disable_Rate*Normal TT per units(s)	0.528	0.29671
Normal_Yield*Normal_Disable_Rate*Retest TT per units(s)	0.481	0.33033
Normal_Yield*Normal_Disable_Rate	0.424	0.37687
Normal TT per units(s)	0.422	0.37857
Normal_Disable_Rate*Normal TT per units(s)*Retest TT per units(s)	0.297	0.50414
Normal_Yield*Normal TT per units(s)	0.276	0.52912
Normal_Yield*Normal_Disable_Rate*Normal TT per units(s)*Retest Yield	0.262	0.54701
Normal_Yield*Normal TT per units(s)*Retest TT per units(s)	0.242	0.57264
Normal_Yield*Normal_Disable_Rate*Retest Yield*Retest TT per units(s)	0.215	0.60901
Normal_Yield*Normal_Disable_Rate*Retest Yield	0.148	0.71048
Normal_Yield*Normal_Disable_Rate*Normal TT per units(s)*Retest Yield*Retest TT per units(s)	0.141	0.72266
Normal_Disable_Rate*Retest TT per units(s)	0.067	0.85739
Normal_Disable_Rate	0.046	0.89849

Summary of Fit

RSquare 0.570324
 RSquare Adj 0.489105
 Observations (or Sum Wgts) 196

Simulator

Responses

Retest_Disable_Rate

N Runs: 5000

Prediction Profiler

Retest_Disable_Rate

Y response

Normal Yield	Normal_Disable_Rate	Normal TT per units(s)	Retest Yield	Retest TT per units(s)
Random	Random	Random	Random	Random
Normal	Normal	Normal	Normal	Normal
Mean SD	Mean SD	Mean SD	Mean SD	Mean SD

Screening the significant factors

X factors

Mean value source: Customer required
 SD value source: Historical data

How to perform Monte Carlo Simulation in JMP Pro.?

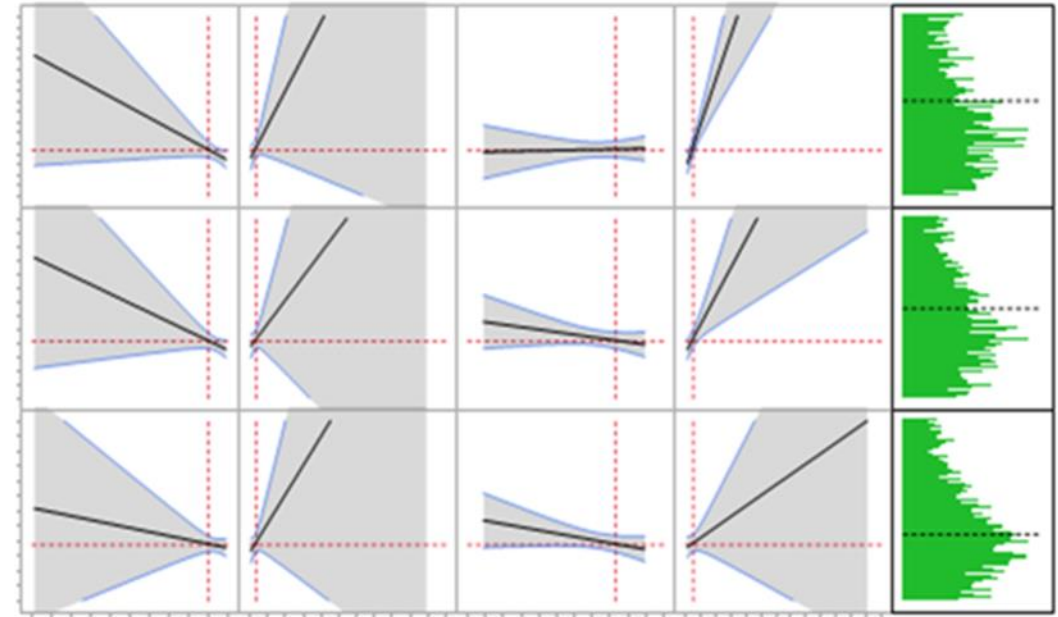
Prediction Profiler

The calculated site disable rate response (Based on customer requirement) should be regarded as *criteria* and reflect in the dashboard

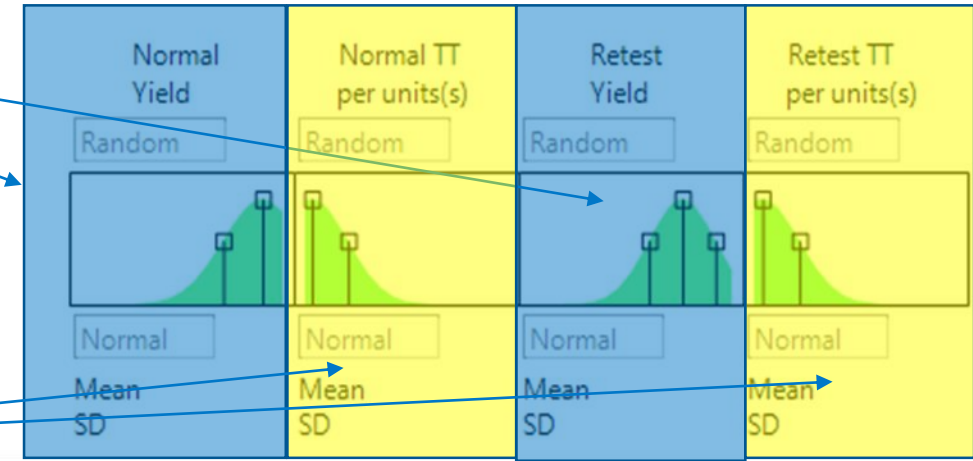
Normal_Disabl
e_Rate

N+R Disable
Rate

Retest_Disabl
_Rate



Yield Mean from customer requirement system



Test time Mean from customer requirement system

Summary

- Establish the relationship between customer requirement and operation tactical KPI
- Use JMP Pro. Version to validate the prototype and shorten the project cycle time
- Fan out the model to other business area to maximize the benefit
- Regular refresh the model to make it update and effective



MAKE IT
CHALLENGE

JMP is great tool to enable engineers to use modeling for problem solving.

Q & A

