FOURTEENTH ANNUAL
BiTS 2013
Burn-in & Test Strategies Workshop™

Archive
Session 1

STREAMLINING OPERATIONS

Test operations, generally considered costly, yet necessary, add value to device manufacturing when optimized for efficiency. This session offers a variety of approaches that promise high yields, lean manufacturing, maximized performance at minimal costs, and optimized production times. The first paper discusses a method of incorporating multidimensional Monte Carlo analysis simulation with known design parameters to focus manufacturing improvement efforts and maximize alignment performance while minimizing costs. Presented next is a method for redefining test tooling design rules to gain process margin and prevent substrate chipping caused by test handler misalignment. Zero-cost, software based, virtual tool checkers that bring the whole production area towards a manufacturing LEAN direction is then discussed. Wrapping things up is a paper on a screwless socket and dual pin testing concept said to greatly enhance the robustness and efficiency of IC testing.

This Paper

Improving Socket Alignment Performance Using Monte Carlo Analysis Techniques and Manufacturing Controls

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Tooling Stack-up Process Margin Improvement

Mook Koon Wong, Boon Hor Phee—Intel Malaysia

Zero Cost Virtual Tool Checker

Seong Guan Ooi—Intel Technology Sdn. Bhd.

Enablers for Robust & Fast Online Trouble-shooting for High Parallelism Testing

Benedict Loh—Infineon Technologies
Kohei Hironaka—NHK Spring Co. Ltd.
Michelle Ng—TestPro

Improving Socket Alignment Performance Using Monte Carlo Analysis Techniques and Manufacturing Controls

Daniel DelVecchio
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2013 BiTS Workshop
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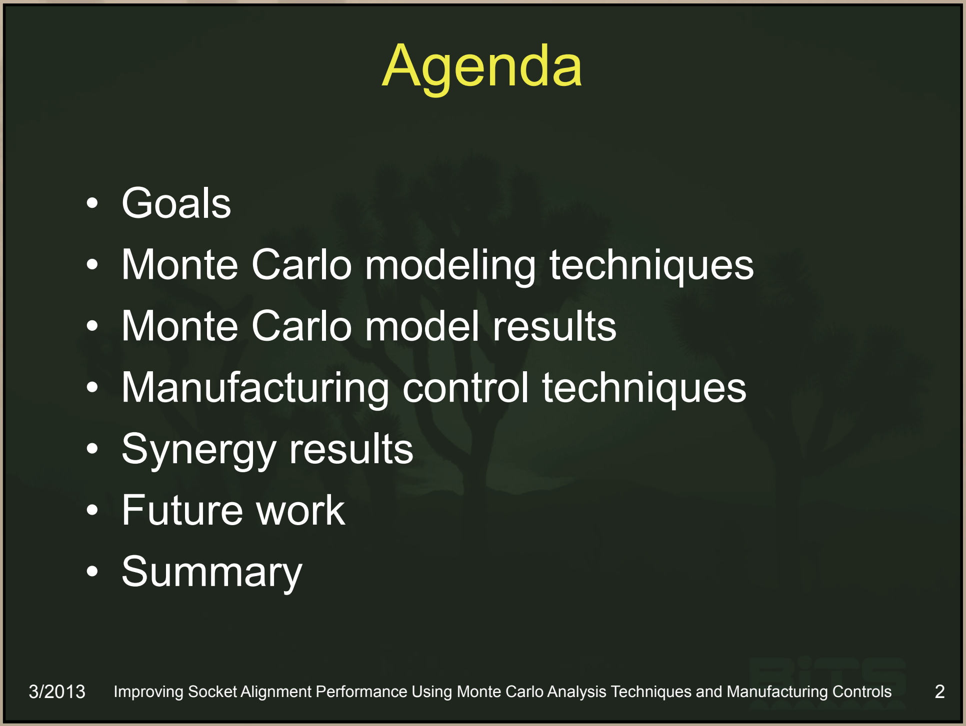
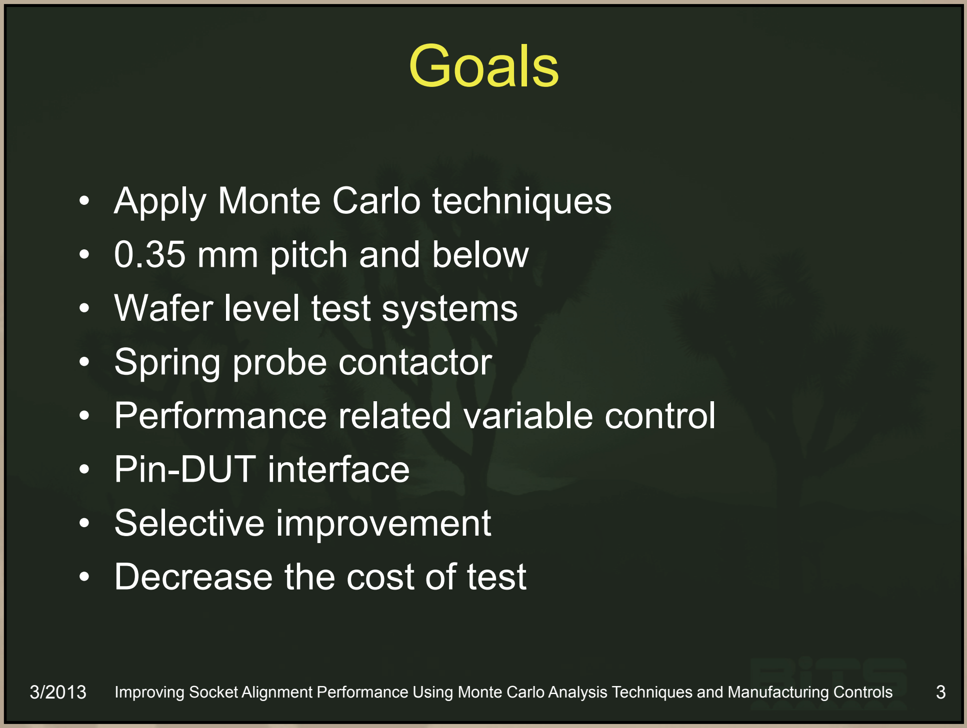


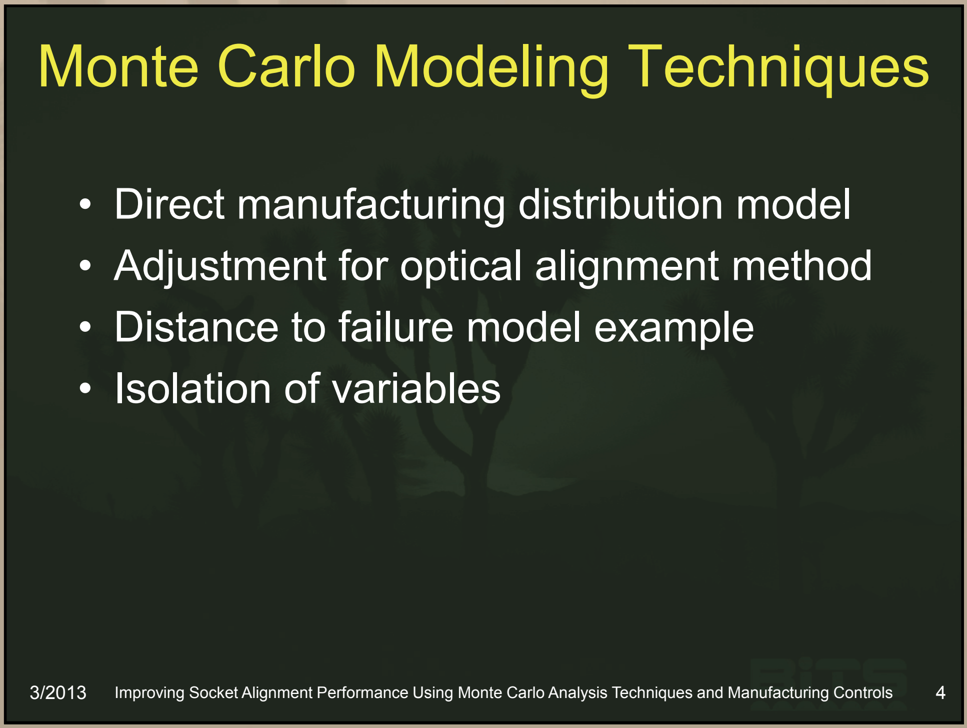
Agenda

- Goals
- Monte Carlo modeling techniques
- Monte Carlo model results
- Manufacturing control techniques
- Synergy results
- Future work
- Summary



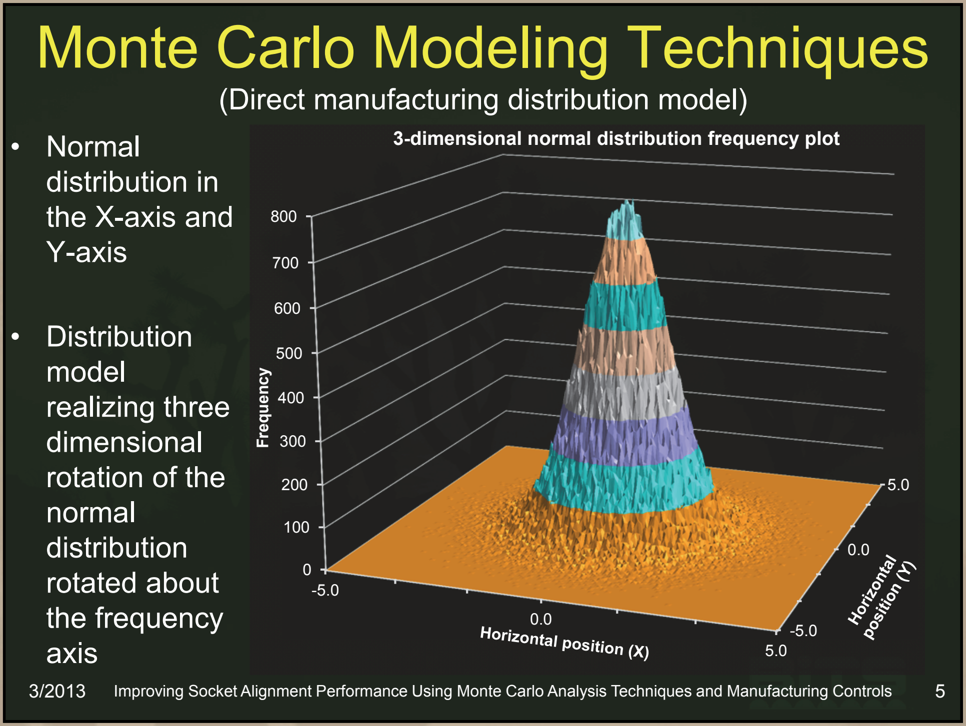
Goals

- Apply Monte Carlo techniques
- 0.35 mm pitch and below
- Wafer level test systems
- Spring probe contactor
- Performance related variable control
- Pin-DUT interface
- Selective improvement
- Decrease the cost of test



Monte Carlo Modeling Techniques

- Direct manufacturing distribution model
- Adjustment for optical alignment method
- Distance to failure model example
- Isolation of variables



Monte Carlo Modeling Techniques

(Direct manufacturing distribution model)

- Normal distribution in the X-axis and Y-axis
- Distribution model realizing three dimensional rotation of the normal distribution rotated about the frequency axis

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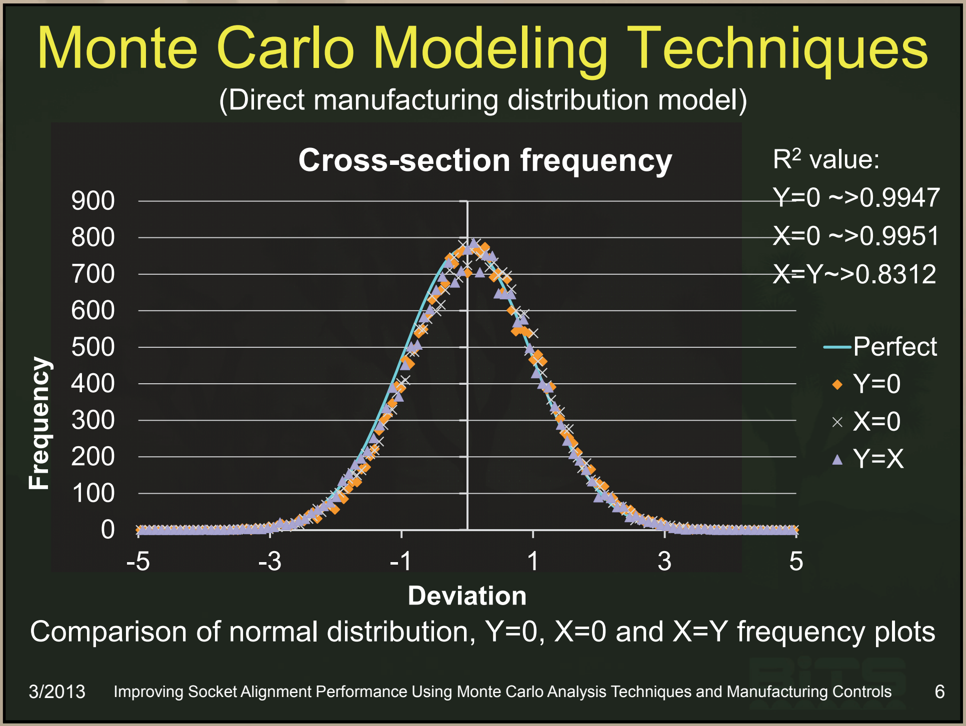

Monte Carlo Modeling Techniques

(Direct manufacturing distribution model)

R^2 value:
Y=0 ~>0.9947
X=0 ~>0.9951
X=Y~>0.8312

Comparison of normal distribution, Y=0, X=0 and X=Y frequency plots

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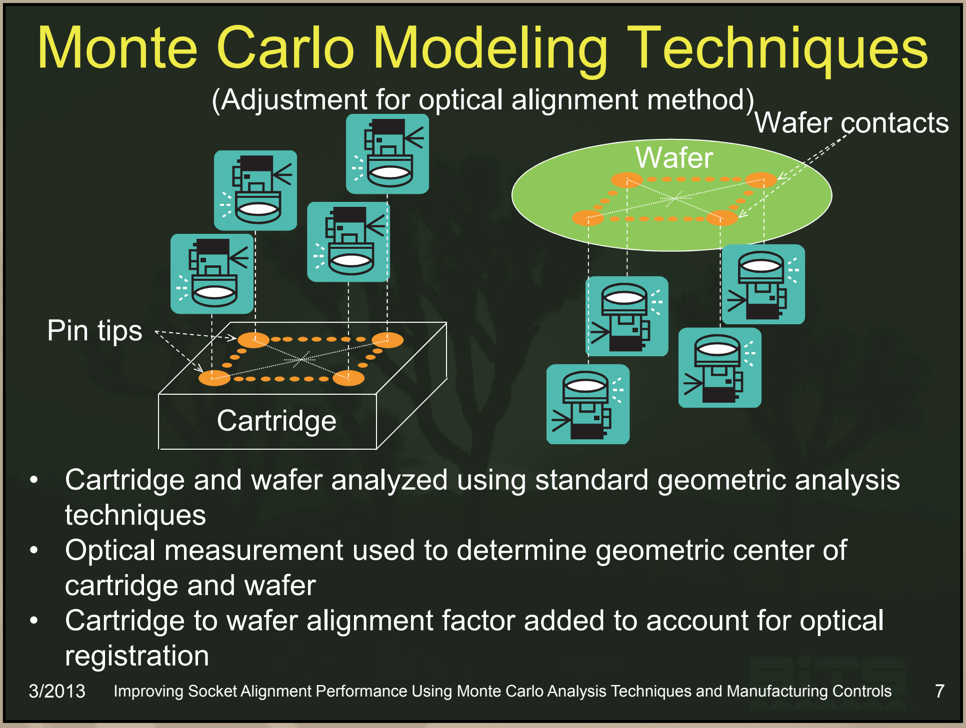
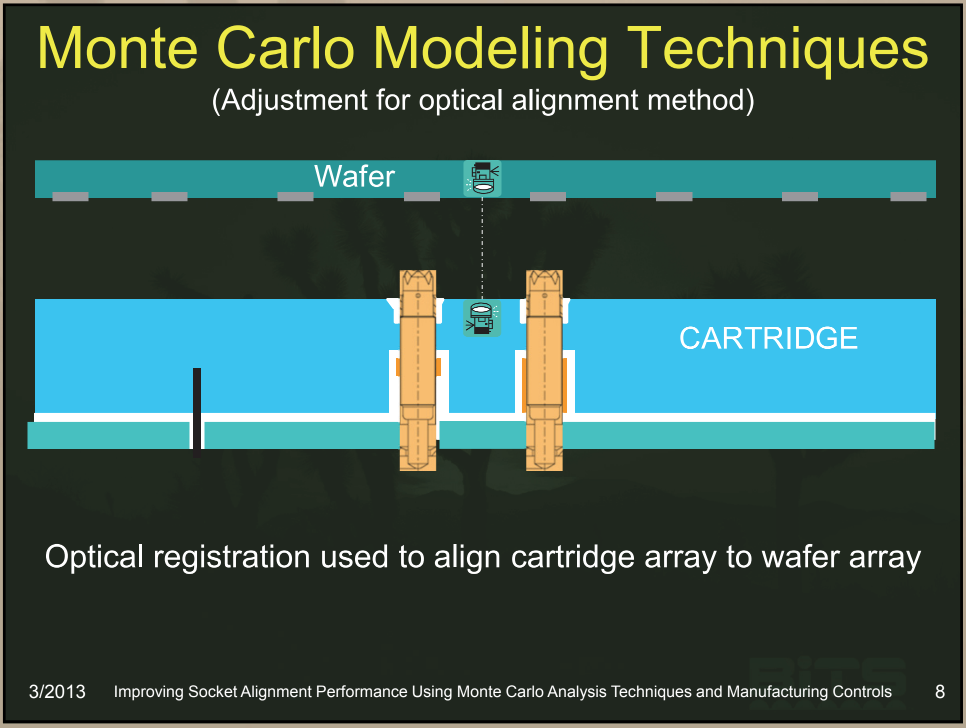


Monte Carlo Modeling Techniques

(Adjustment for optical alignment method)

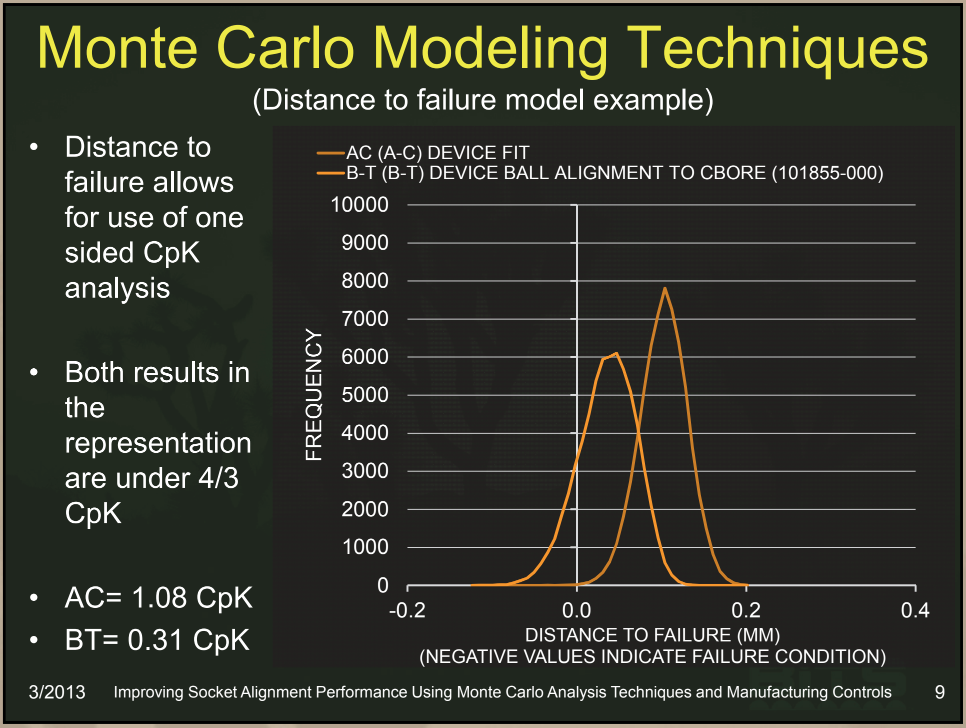
- Cartridge and wafer analyzed using standard geometric analysis techniques
- Optical measurement used to determine geometric center of cartridge and wafer
- Cartridge to wafer alignment factor added to account for optical registration



Monte Carlo Modeling Techniques

(Adjustment for optical alignment method)

Optical registration used to align cartridge array to wafer array



Monte Carlo Modeling Techniques

(Distance to failure model example)

- Distance to failure allows for use of one sided CpK analysis
- Both results in the representation are under 4/3 CpK
- AC= 1.08 CpK
- BT= 0.31 CpK

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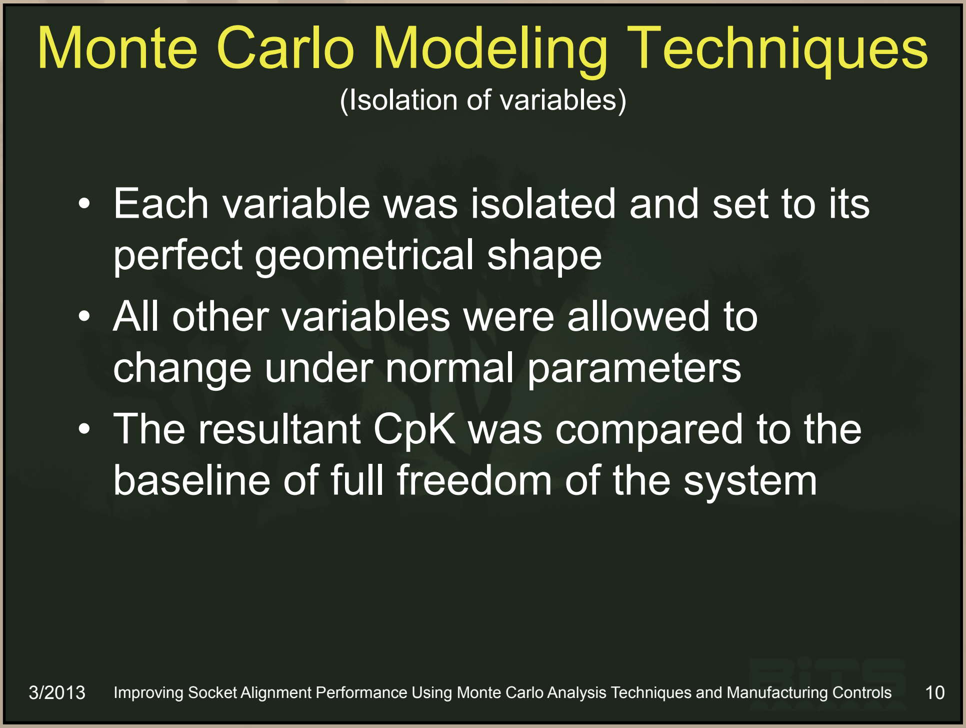

Monte Carlo Modeling Techniques

(Isolation of variables)

- Each variable was isolated and set to its perfect geometrical shape
- All other variables were allowed to change under normal parameters
- The resultant CpK was compared to the baseline of full freedom of the system

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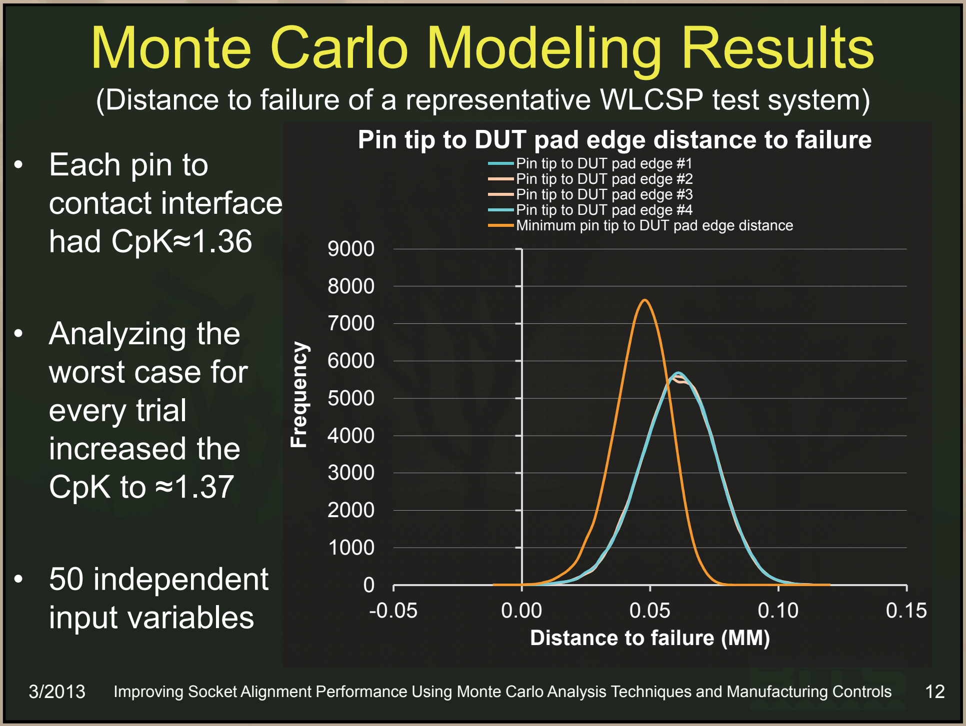
Monte Carlo Model Results

- Distance to failure of a representative WLCSP test system
- Contribution to CpK of each relevant parameter
- Contribution to CpK of each parameter as a function of individual standard deviation
- Summary

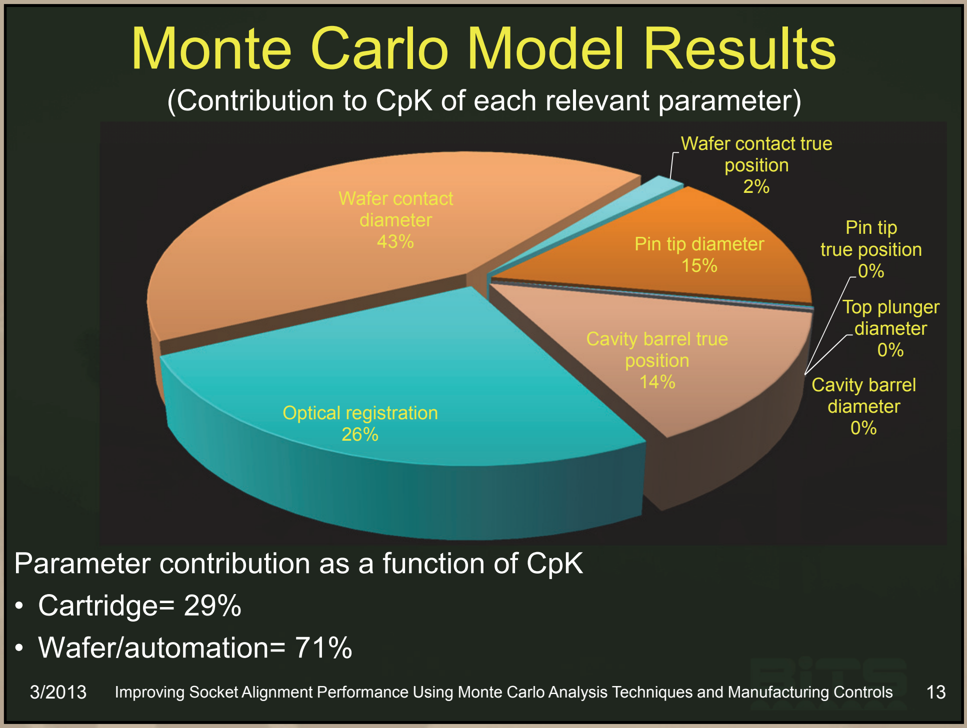


Monte Carlo Modeling Results

(Distance to failure of a representative WLCSP test system)

- Each pin to contact interface had CpK≈1.36
- Analyzing the worst case for every trial increased the CpK to ≈1.37
- 50 independent input variables

Pin tip to DUT pad edge distance to failure



Monte Carlo Model Results

(Contribution to CpK of each relevant parameter)

Parameter contribution as a function of CpK

- Cartridge= 29%
- Wafer/automation= 71%

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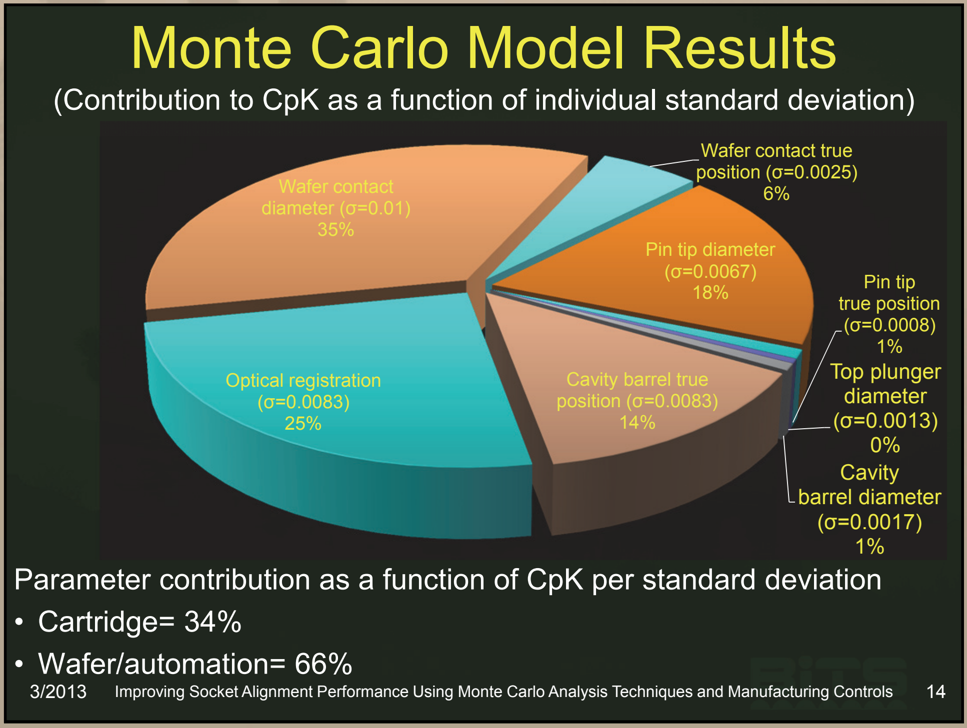

Monte Carlo Model Results

(Contribution to CpK as a function of individual standard deviation)

Parameter contribution as a function of CpK per standard deviation

- Cartridge= 34%
- Wafer/automation= 66%

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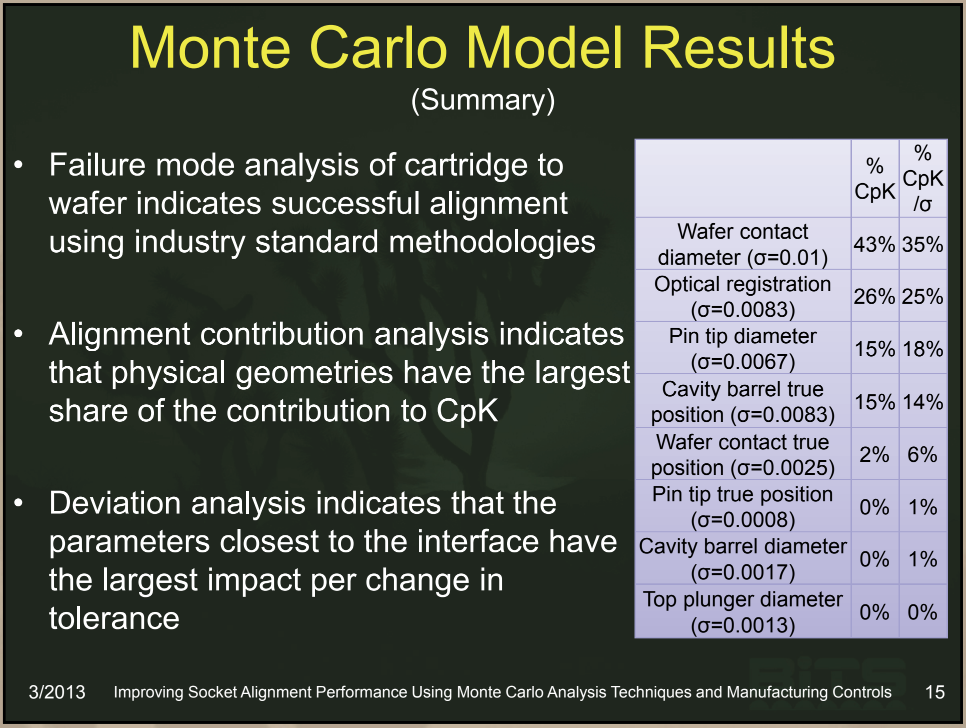

Monte Carlo Model Results

(Summary)

- Failure mode analysis of cartridge to wafer indicates successful alignment using industry standard methodologies
- Alignment contribution analysis indicates that physical geometries have the largest share of the contribution to CpK
- Deviation analysis indicates that the parameters closest to the interface have the largest impact per change in tolerance

	% CpK	% CpK /σ
Wafer contact diameter (σ=0.01)	43%	35%
Optical registration (σ=0.0083)	26%	25%
Pin tip diameter (σ=0.0067)	15%	18%
Cavity barrel true position (σ=0.0083)	15%	14%
Wafer contact true position (σ=0.0025)	2%	6%
Pin tip true position (σ=0.0008)	0%	1%
Cavity barrel diameter (σ=0.0017)	0%	1%
Top plunger diameter (σ=0.0013)	0%	0%

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Manufacturing Control Techniques

- Controlled variable testing
- Tool wear study
- Improvement cost analysis

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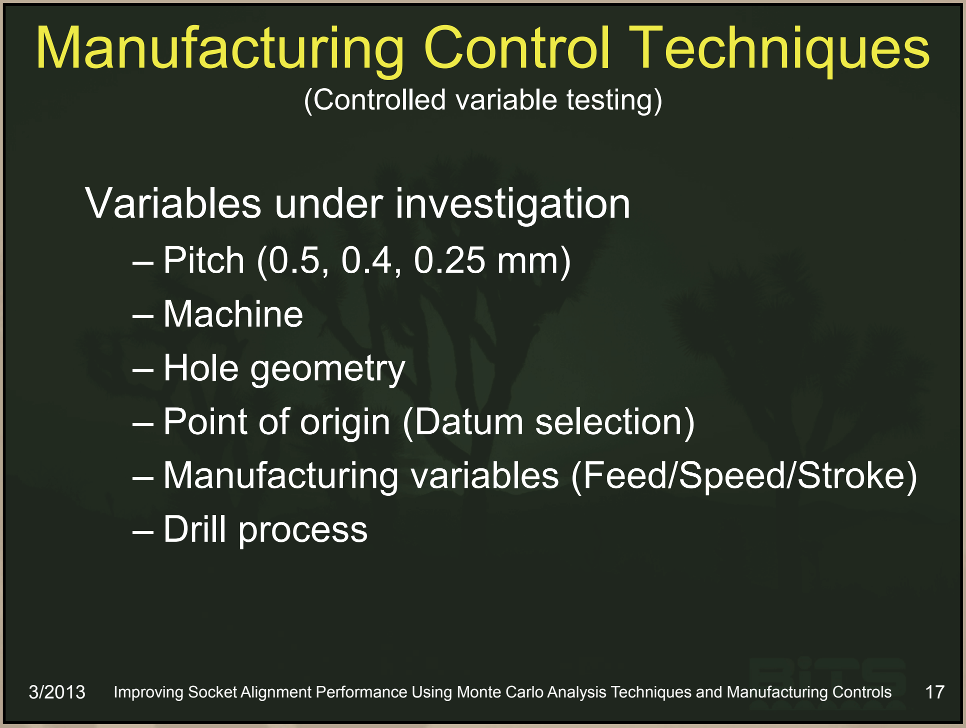
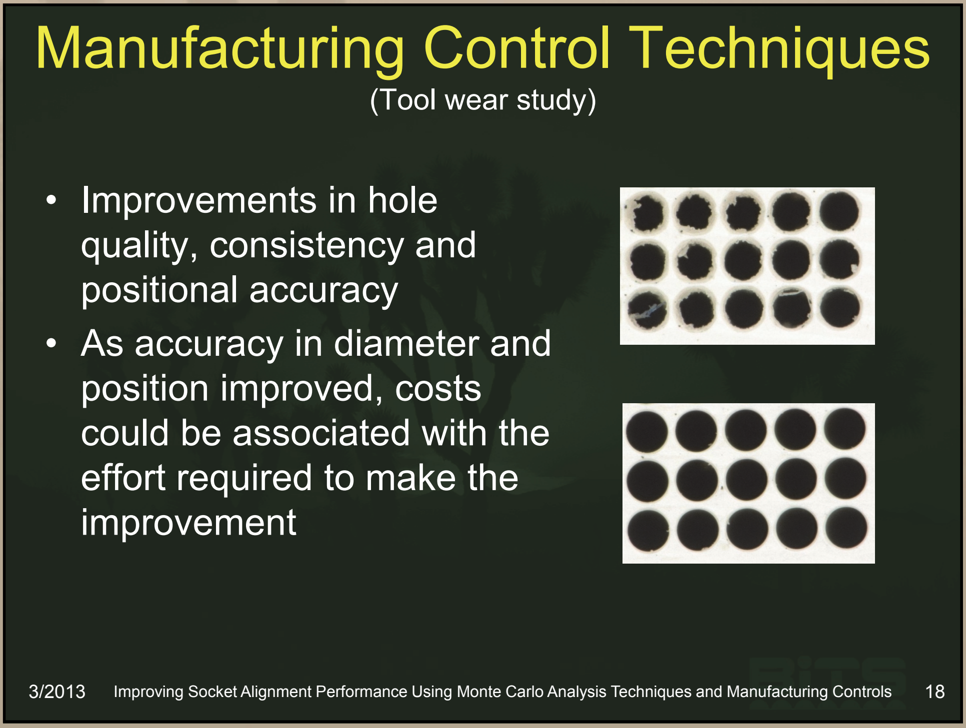


Manufacturing Control Techniques

(Controlled variable testing)

Variables under investigation

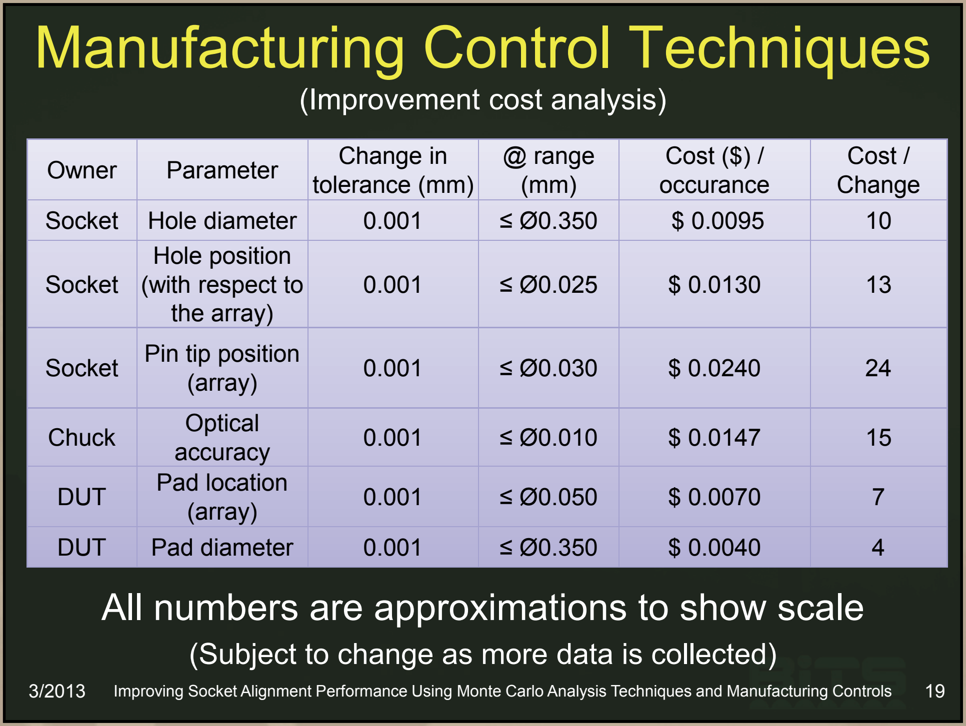
- Pitch (0.5, 0.4, 0.25 mm)
- Machine
- Hole geometry
- Point of origin (Datum selection)
- Manufacturing variables (Feed/Speed/Stroke)
- Drill process



Manufacturing Control Techniques

(Tool wear study)

- Improvements in hole quality, consistency and positional accuracy
- As accuracy in diameter and position improved, costs could be associated with the effort required to make the improvement



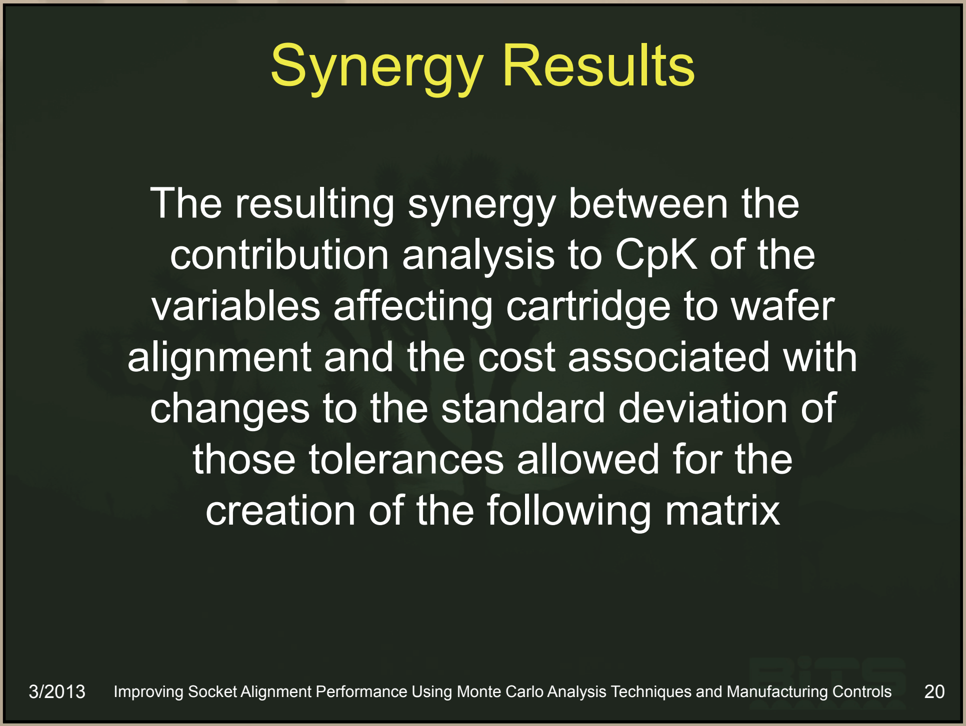
Manufacturing Control Techniques

(Improvement cost analysis)

Owner	Parameter	Change in tolerance (mm)	@ range (mm)	Cost ($) / occurance	Cost / Change
Socket	Hole diameter	0.001	≤ Ø0.350	$ 0.0095	10
Socket	Hole position (with respect to the array)	0.001	≤ Ø0.025	$ 0.0130	13
Socket	Pin tip position (array)	0.001	≤ Ø0.030	$ 0.0240	24
Chuck	Optical accuracy	0.001	≤ Ø0.010	$ 0.0147	15
DUT	Pad location (array)	0.001	≤ Ø0.050	$ 0.0070	7
DUT	Pad diameter	0.001	≤ Ø0.350	$ 0.0040	4

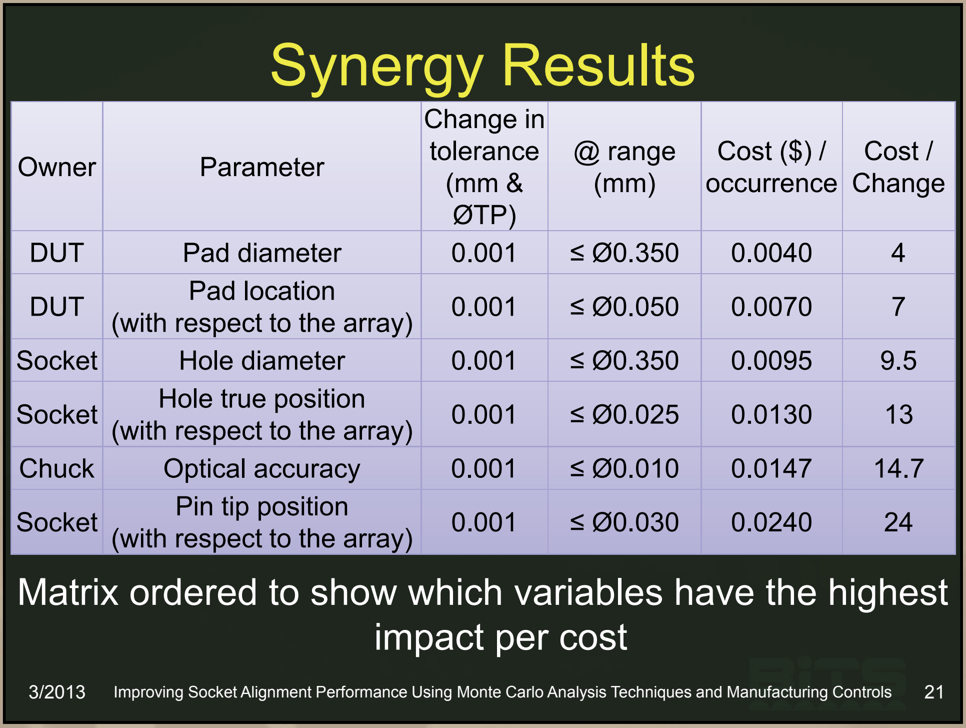
All numbers are approximations to show scale

(Subject to change as more data is collected)



Synergy Results

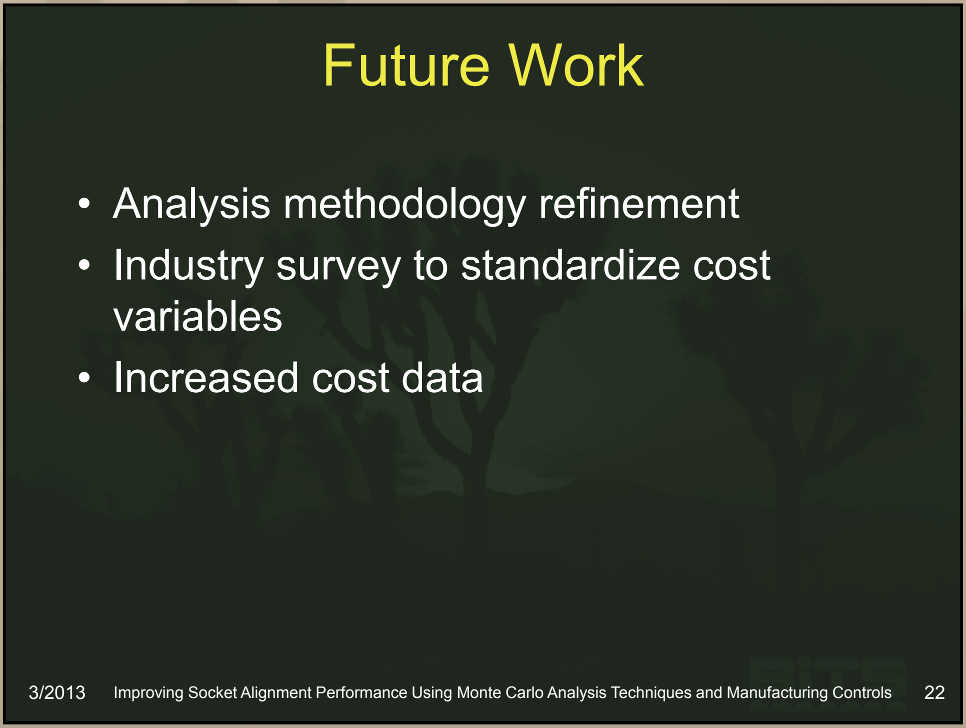
The resulting synergy between the contribution analysis to CpK of the variables affecting cartridge to wafer alignment and the cost associated with changes to the standard deviation of those tolerances allowed for the creation of the following matrix



Synergy Results

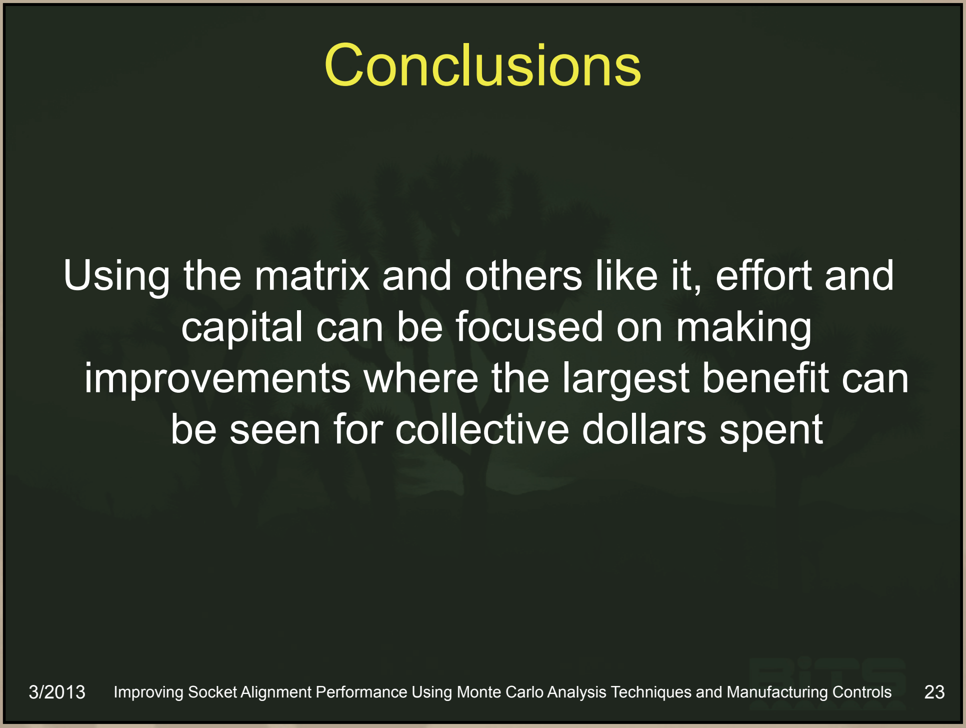
Owner	Parameter	Change in tolerance (mm & ØTP)	@ range (mm)	Cost ($) / occurrence	Cost / Change
DUT	Pad diameter	0.001	≤ Ø0.350	0.0040	4
DUT	Pad location (with respect to the array)	0.001	≤ Ø0.050	0.0070	7
Socket	Hole diameter	0.001	≤ Ø0.350	0.0095	9.5
Socket	Hole true position (with respect to the array)	0.001	≤ Ø0.025	0.0130	13
Chuck	Optical accuracy	0.001	≤ Ø0.010	0.0147	14.7
Socket	Pin tip position (with respect to the array)	0.001	≤ Ø0.030	0.0240	24

Matrix ordered to show which variables have the highest impact per cost



Future Work

- Analysis methodology refinement
- Industry survey to standardize cost variables
- Increased cost data



Conclusions

Using the matrix and others like it, effort and capital can be focused on making improvements where the largest benefit can be seen for collective dollars spent