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Printing Fine Pitch Applications

April 25, 2012

SMTA
Surface Mount Technology Association

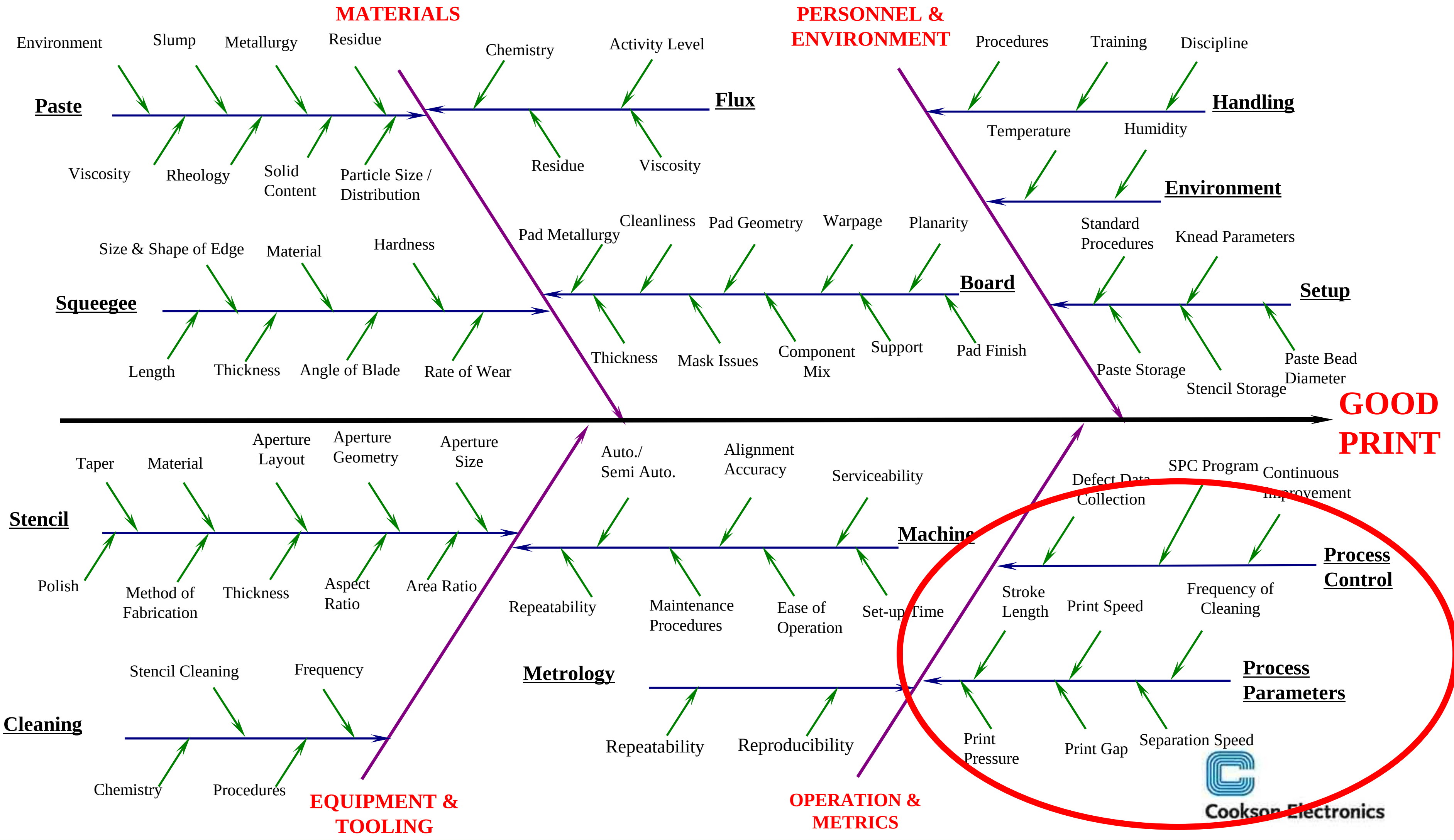
Portland Oregon Chapter

Cookson Electronics

Detailed Cause and Effect

alpha

Fine Feature Printing



MATERIALS

Paste
- Environment
- Slump
- Metallurgy
- Residue
- Viscosity
- Rheology
- Solid Content
- Particle Size / Distribution

Flux
- Chemistry
- Activity Level
- Residue
- Viscosity

Squeegee
- Size & Shape of Edge
- Material
- Hardness
- Length
- Thickness
- Angle of Blade
- Rate of Wear

Board
- Pad Metallurgy
- Cleanliness
- Pad Geometry
- Warpage
- Planarity
- Thickness
- Mask Issues
- Component Mix
- Support
- Pad Finish

PERSONNEL & ENVIRONMENT

Handling
- Procedures
- Training
- Discipline

Environment
- Temperature
- Humidity

Setup
- Standard Procedures
- Knead Parameters
- Paste Storage
- Stencil Storage
- Paste Bead Diameter

GOOD PRINT

EQUIPMENT & TOOLING

Stencil
- Taper
- Material
- Aperture Layout
- Aperture Geometry
- Aperture Size
- Polish
- Method of Fabrication
- Thickness
- Aspect Ratio
- Area Ratio

Cleaning
- Stencil Cleaning
- Frequency
- Chemistry
- Procedures

Machine
- Auto./ Semi Auto.
- Alignment Accuracy
- Serviceability
- Repeatability
- Maintenance Procedures
- Ease of Operation
- Set-up Time

OPERATION & METRICS

Metrology
- Repeatability
- Reproducibility

Process Control
- Defect Data Collection
- SPC Program
- Continuous Improvement

Process Parameters
- Stroke Length
- Print Speed
- Frequency of Cleaning
- Print Pressure
- Print Gap
- Separation Speed

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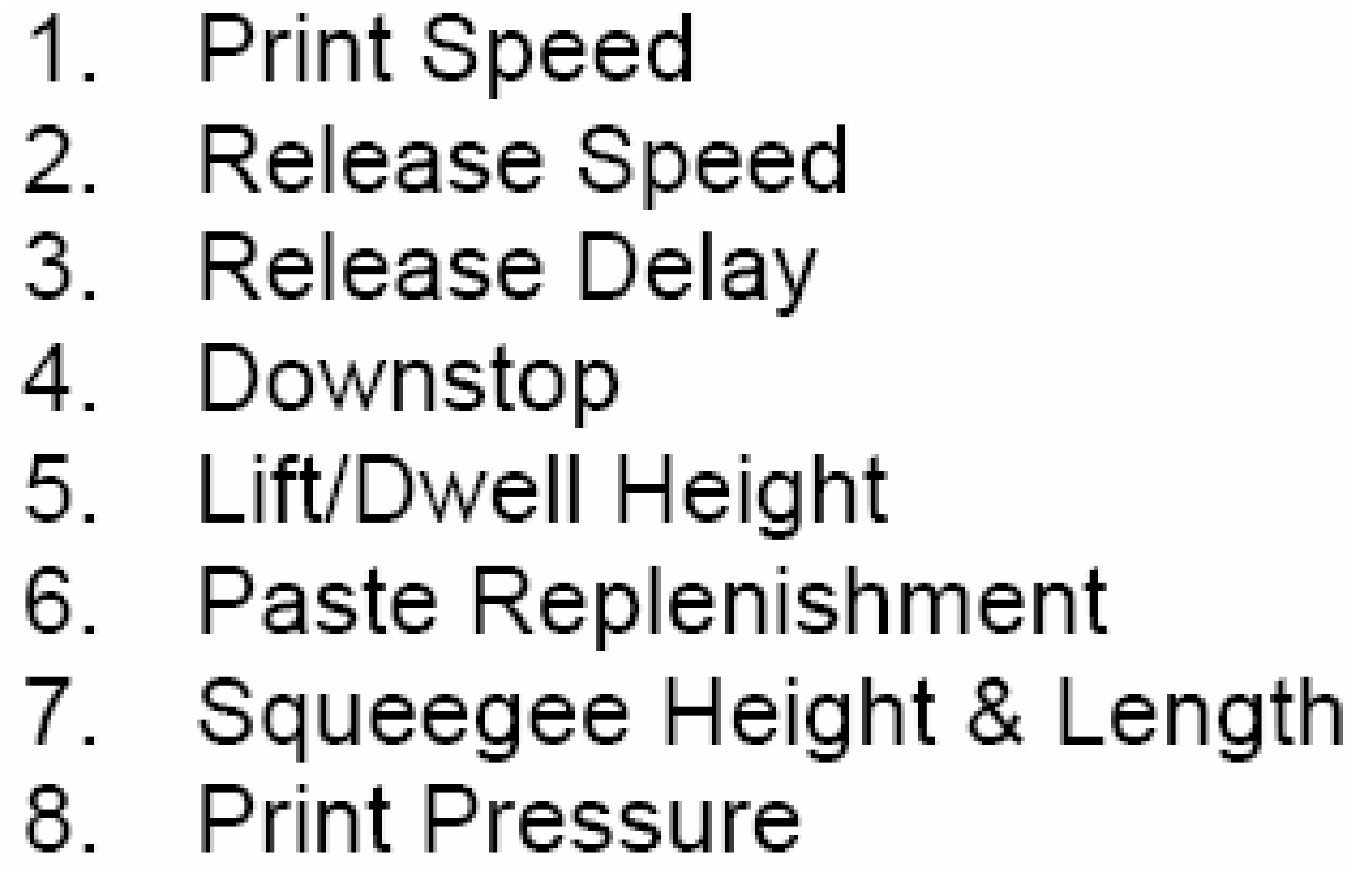
Print Process Parameters



1. Print Speed
2. Release Speed
3. Release Delay
4. Downstop
5. Lift/Dwell Height
6. Paste Replenishment
7. Squeegee Height & Length
8. Print Pressure

Print Process Parameters

1. PRINT SPEED

Always observe recommended squeegee speed for specific solder paste products. Note that different speeds may be preferred to maximize print performance for different solder pastes. Certain latest generation solder pastes like OM-338 Series are designed to print fast based on their high shear/fast response characteristics. The table below provides conversion between metric and imperial values.

Inch/sec									
1"	2"	3"	4"	5"	6"	7"	8"	9"	10"
25	50	75	100	125	150	175	200	225	250
mm/sec									

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Print Process Parameters

2. RELEASE SPEED

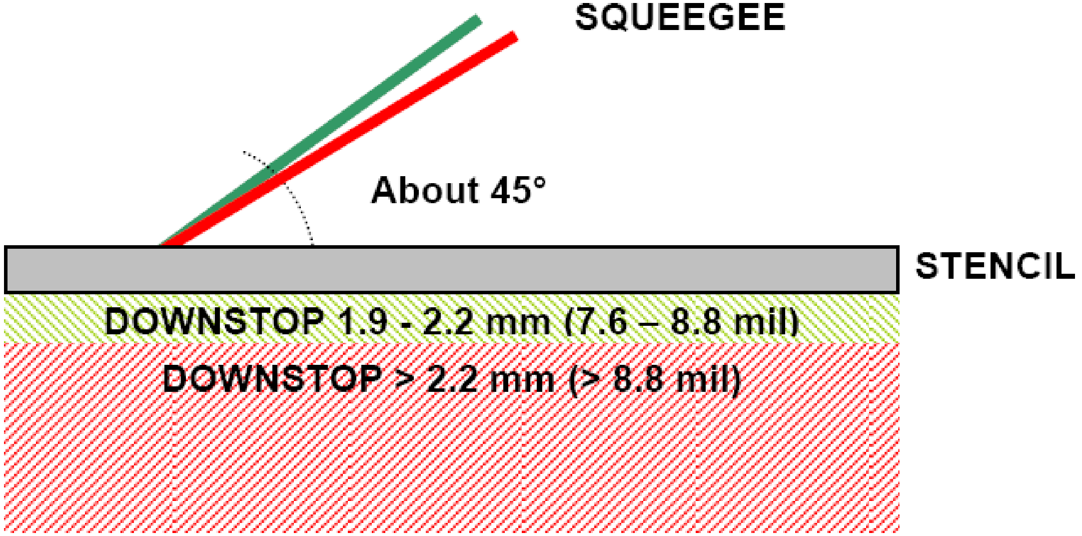
Observe recommended release speed for specific solder paste products. Note that certain latest generation products require fast release speeds (or no release speed), based on the thixotropic nature of these products (like OM-6000 and OM-338 Series). Use a microscope to judge the different print results with different release speeds.

3. RELEASE DELAY

For solder paste stencil printing, never use a release delay to avoid solder paste from adhering to the aperture walls in the stencil.

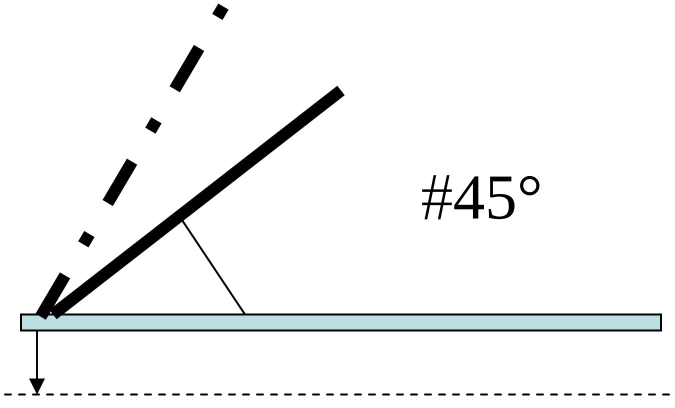
4. DOWNSTOP

For good printing, the squeegee downstop should be set at 1.9 to 2.2 mm (7.6 – 8.8 mil) to avoid excessive squeegee bending, resulting in solder paste sticking to the squeegee holder. The squeegee angle should be approximately 45°.

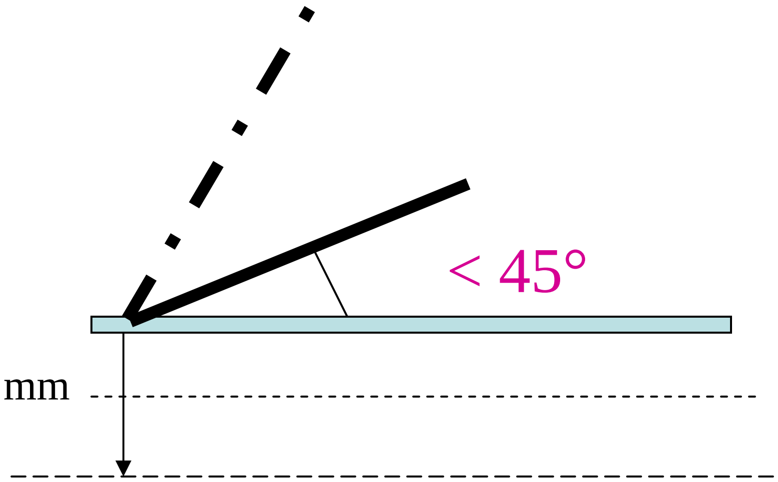


Down-stop on MPM printers

- Normal Setting: 1.9 - 2.2 mm



- Bad Downstop



Bad Down-stop Effect...

Poor Solderpaste rolling

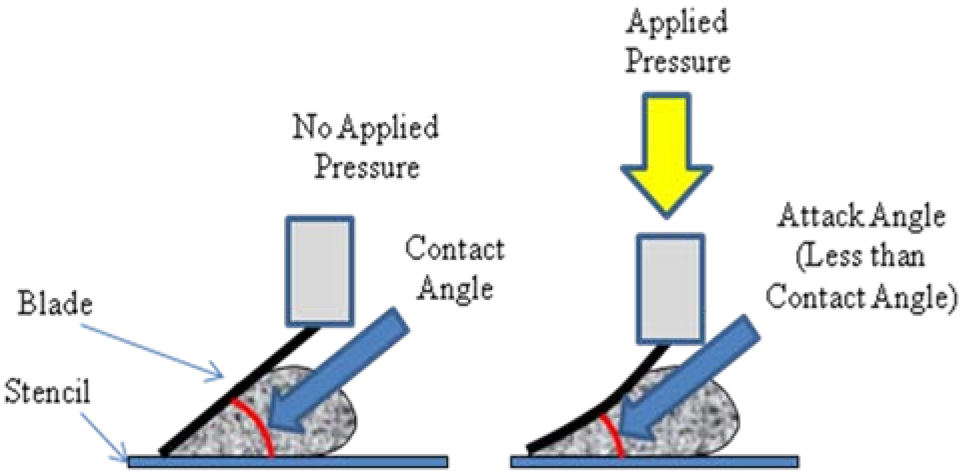
Bad apertures filling

Insufficient deposit in small apertures.

Sticky on blades phenomenon with short height’s

Attack Angle

- Combination of Static and Dynamic Angles
- Low Angle May Improve Paste Packing
- Most Important with Low Area Ratio
- f(Blade Compliancy, Blade Holder, Print Speed and Print Pressure)



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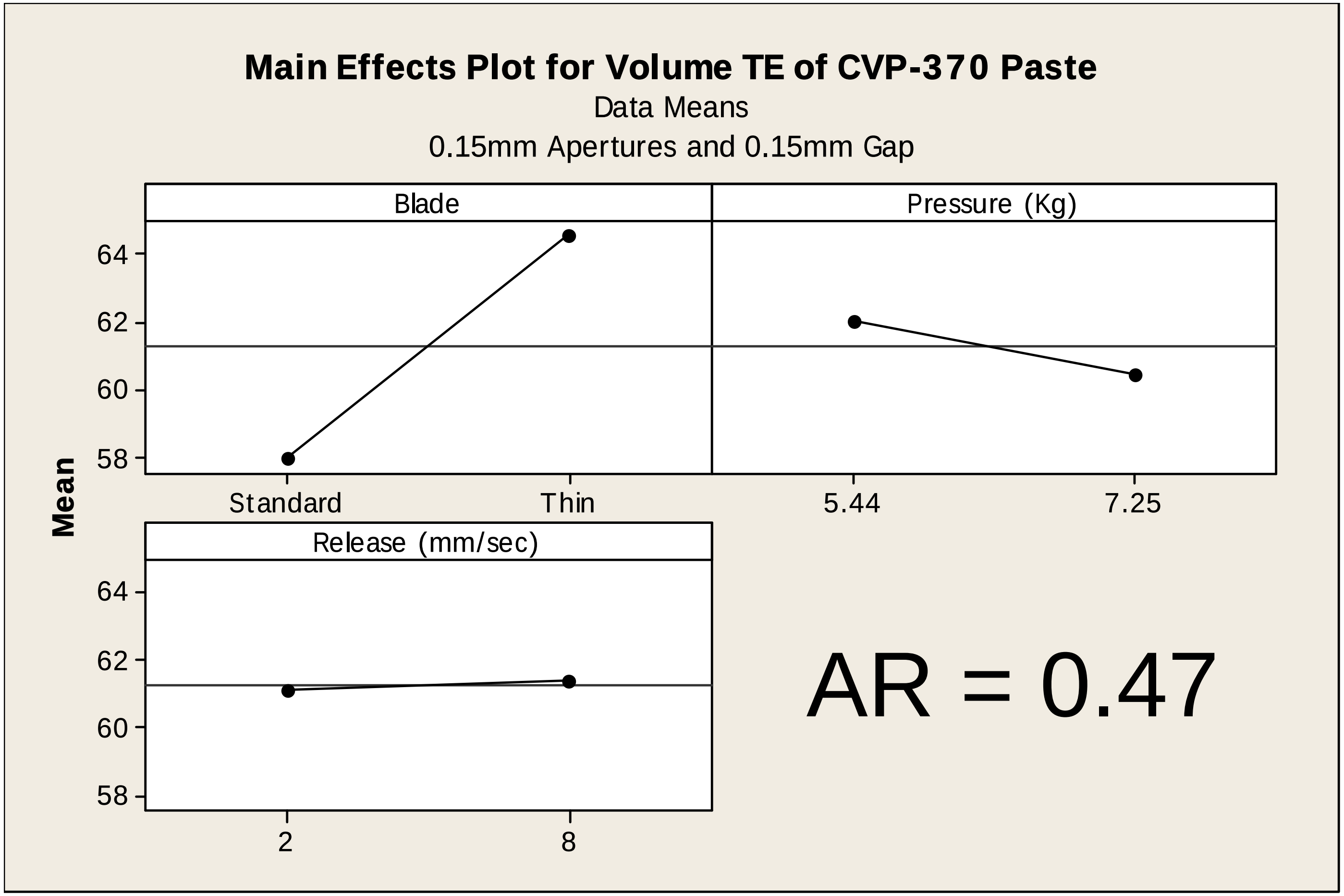
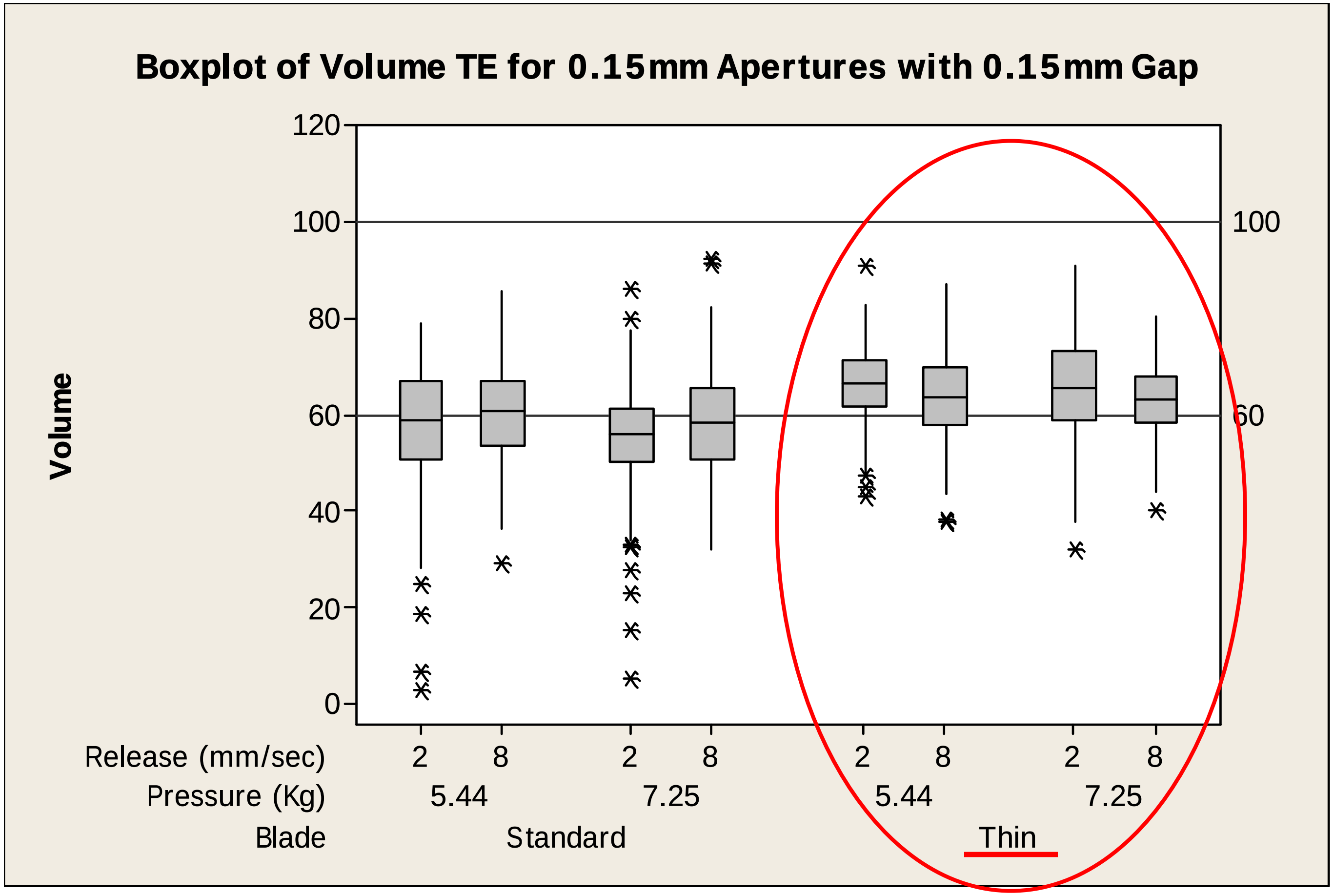
Main Effects for 0.3mm Pitch/01005



Thin Blade is 30% reduced from Thick Blade

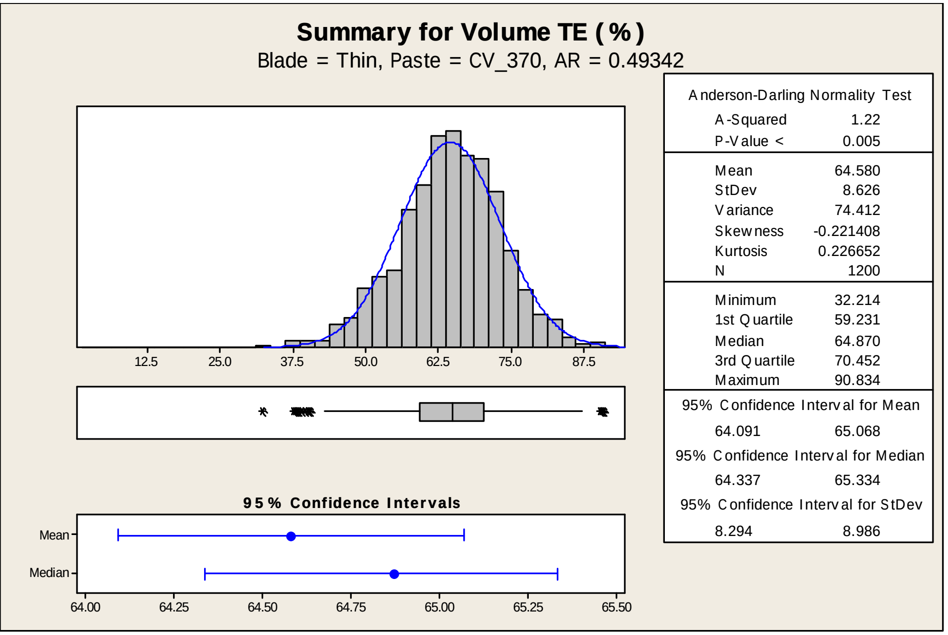
Fine Feature Printing

0.3mm Pitch, AR = 0.47



- Fewer Outliers with 30%Thinner Blade
- More Volume TE with 30% Thinner Blade

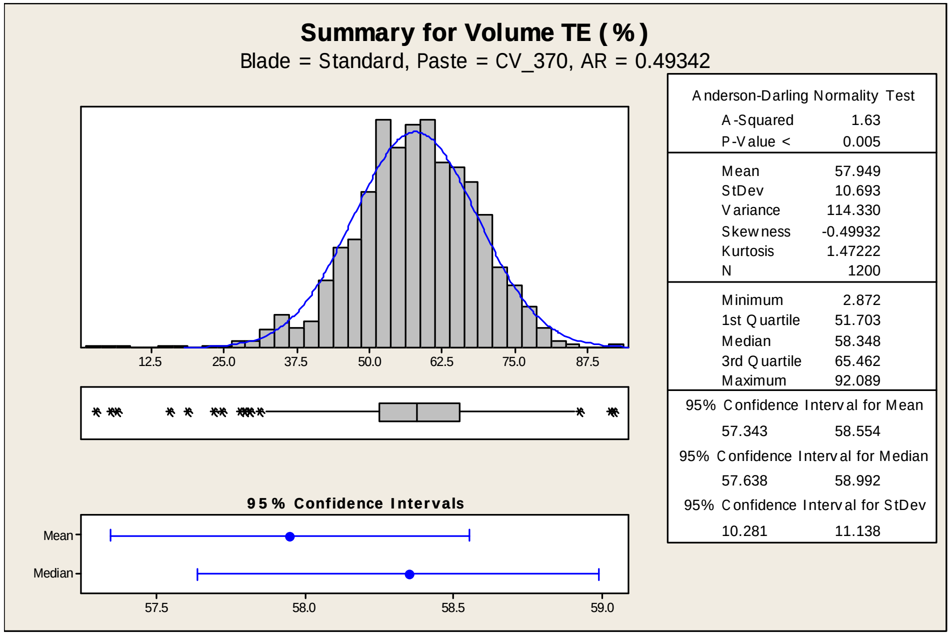
Distribution for 0.3mm Pitch, AR = 0.47



Summary for Volume TE (%)

Blade = Thin, Paste = CV_370, AR = 0.49342

Anderson-Darling Normality Test	
A-Squared	1.22
P-Value <	0.005
Mean	64.580
StDev	8.626
Variance	74.412
Skewness	-0.221408
Kurtosis	0.226652
N	1200
Minimum	32.214
1st Quartile	59.231
Median	64.870
3rd Quartile	70.452
Maximum	90.834
95% Confidence Interval for Mean	
64.091	65.068
95% Confidence Interval for Median	
64.337	65.334
95% Confidence Interval for StDev	
8.294	8.986



Summary for Volume TE (%)

Blade = Standard, Paste = CV_370, AR = 0.49342

Anderson-Darling Normality Test	
A-Squared	1.63
P-Value <	0.005
Mean	57.949
StDev	10.693
Variance	114.330
Skewness	-0.49932
Kurtosis	1.47222
N	1200
Minimum	2.872
1st Quartile	51.703
Median	58.348
3rd Quartile	65.462
Maximum	92.089
95% Confidence Interval for Mean	
57.343	58.554
95% Confidence Interval for Median	
57.638	58.992
95% Confidence Interval for StDev	
10.281	11.138

- 30% Thinner Blade
  - Tighter Distribution
  - Greater average Transfer Efficiency

Fine Feature Printing – Key Inputs

Printer

- – Blades
  - Attack Angle
  - Print Speed - *f*(paste and thru put)
  - Blade Pressure – *f*(print speed and attack angle)
  - Stencil Release Rate – *f*(paste and aperture)
- – Board Support
  - Dedicated vs. Pins
- – Board Clamping
  - Edge vs. Top

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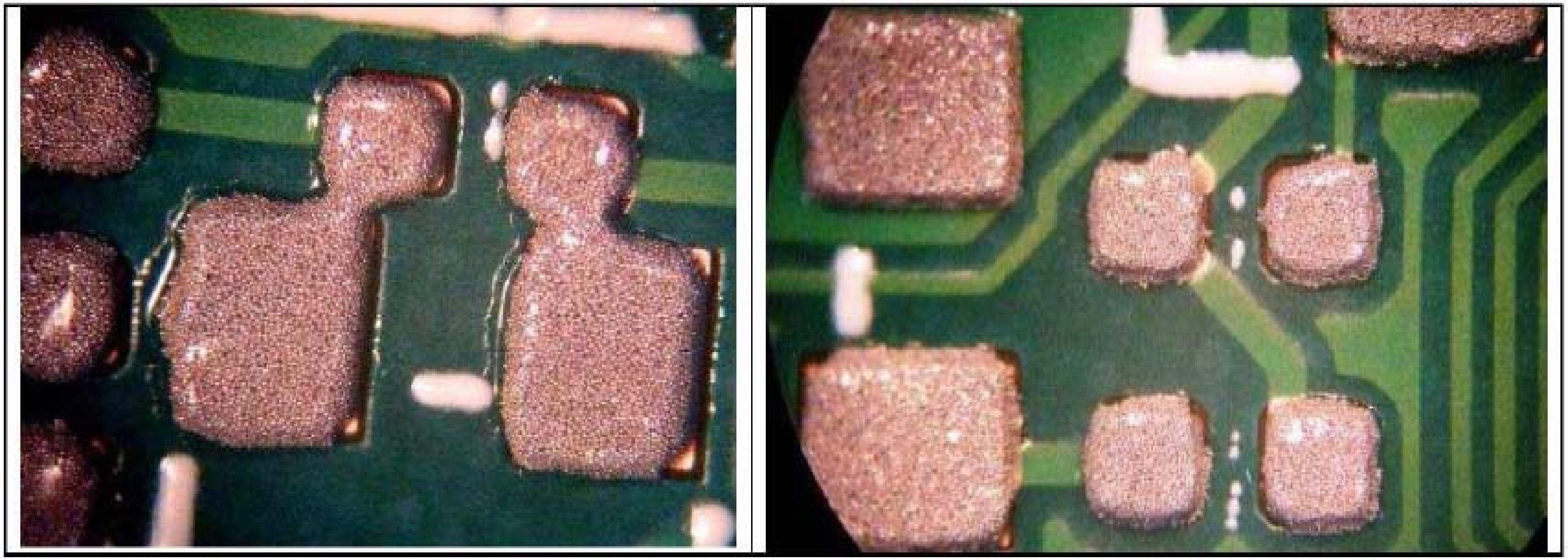
Print Process Parameters

The 0.5 mm pitch CSP's is too close the printer clamping:

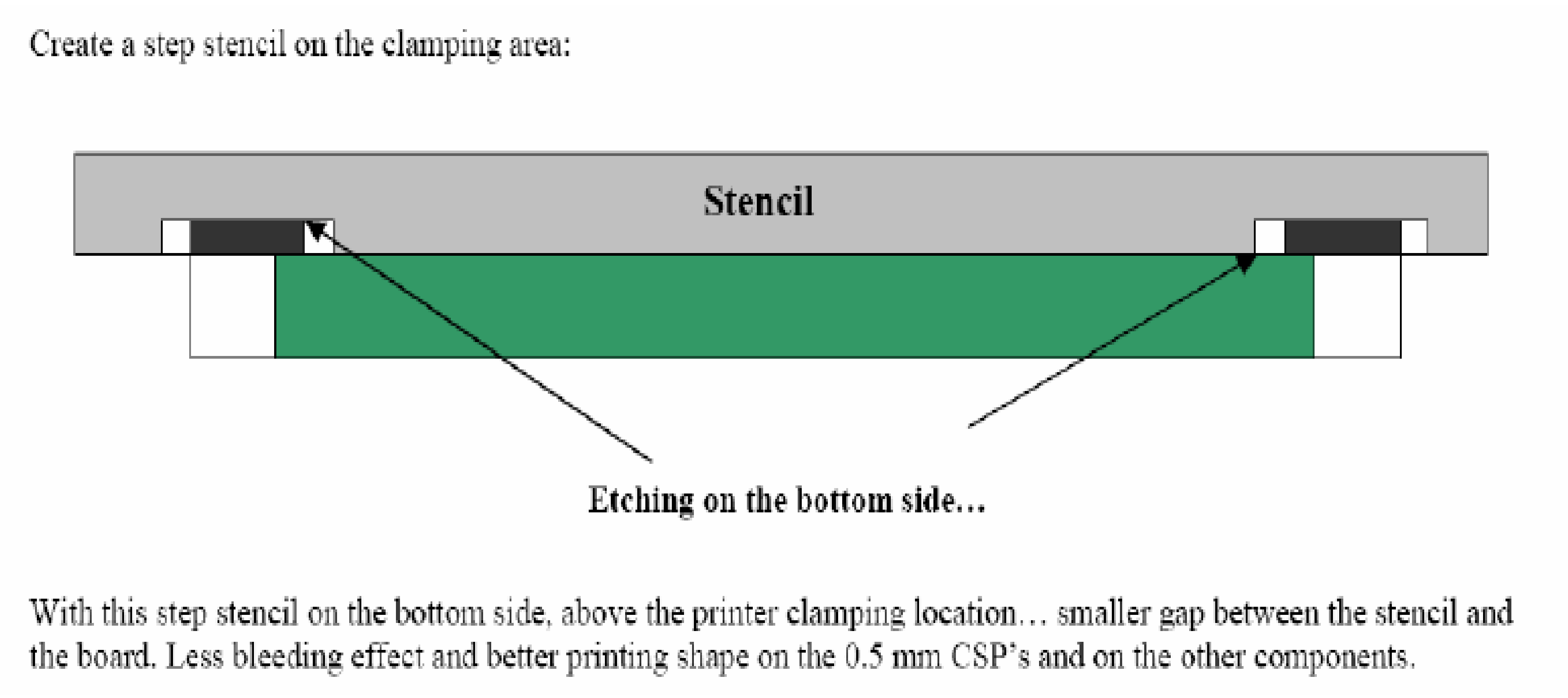
Print Process Parameters

So near the clamping area there is a ***gap between the stencil and the board***… more bleeding effect:



Poor shape…. Solderpaste connection phenomenon.

Print Process Parameters



Create a step stencil on the clamping area:

Stencil

Etching on the bottom side…

With this step stencil on the bottom side, above the printer clamping location… smaller gap between the stencil and the board. Less bleeding effect and better printing shape on the 0.5 mm CSP's and on the other components.

Detailed Cause and Effect

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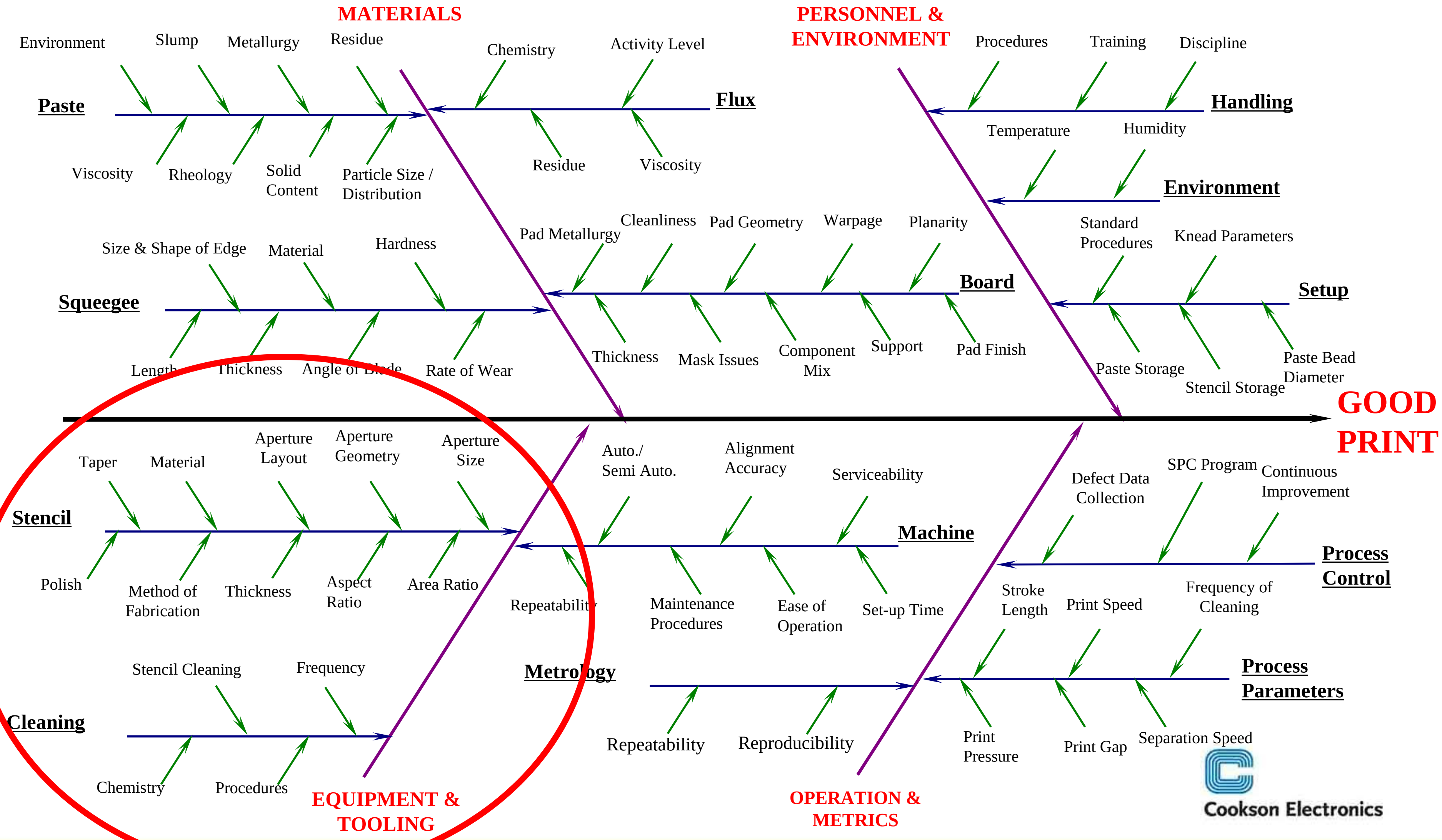
Fine Feature Printing



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- Paste Storage
- Stencil Storage
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- Thickness
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- Frequency
- Chemistry
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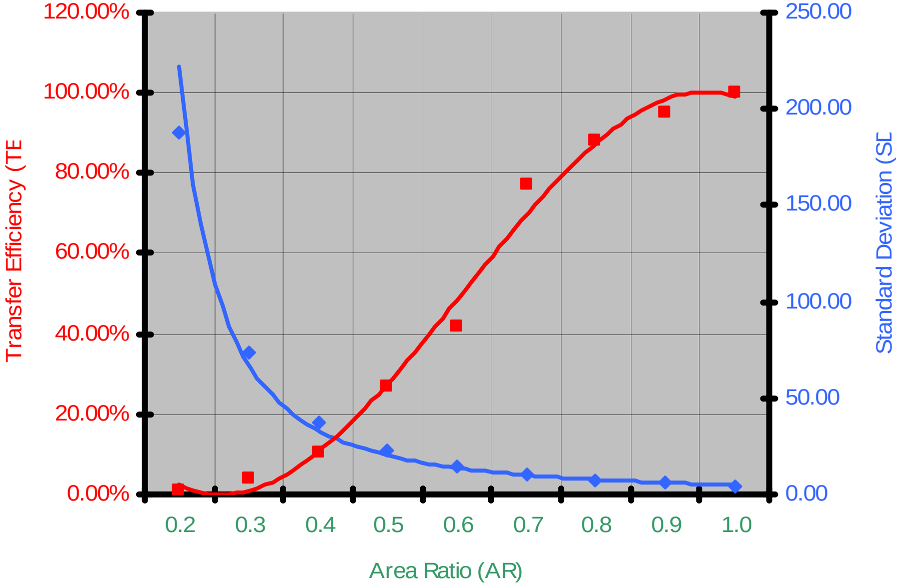
Stencil Technologies

AREA RATIO, and the effect of aperture wall smoothness on Area Ratio, is the primary factor that determines paste transfer



$$\text{Area Ratio} = \frac{\text{Aperture Opening Area}}{\text{Aperture Wall Area}}$$

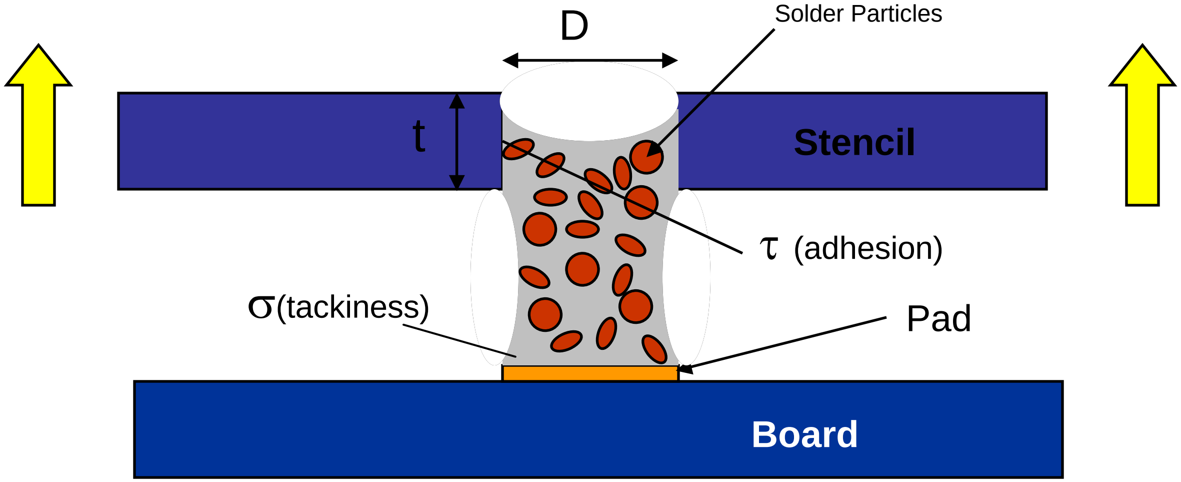
$$\text{Transfer Efficiency} = \frac{\text{Volume Deposit}}{\text{Volume Aperture}}$$

Smooth aperture wall – Higher paste transfer

High Area Ratio - High Transfer Efficiency

- Low Standard Deviation

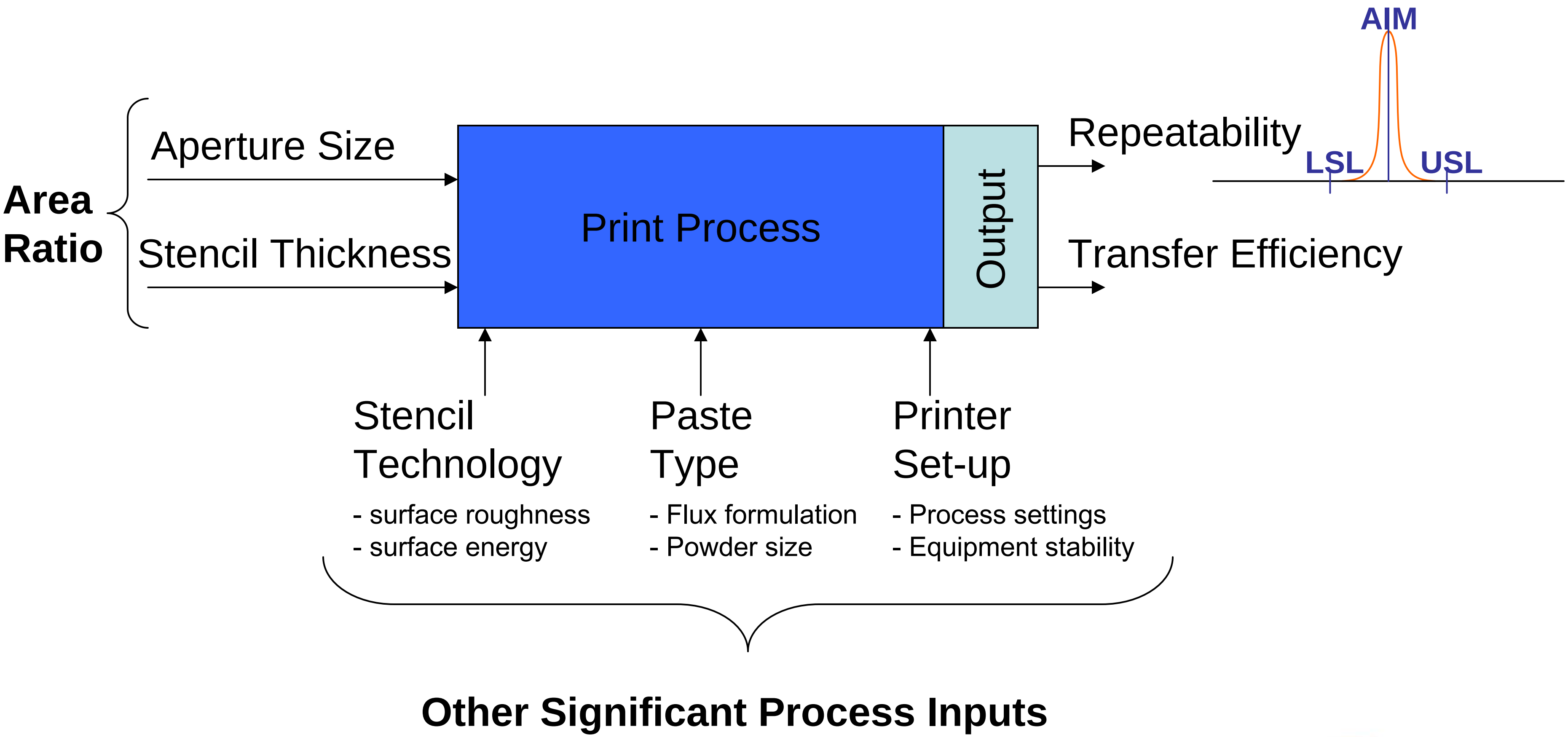
Problem Definition



- As the stencil moves away from the board, the paste experiences forces at the aperture walls and pad surface that define print quality.

Print Process

Goal: Map out the total print process.



Area Ratio

Aperture Size

Stencil Thickness

Print Process

Output

Repeatability

Transfer Efficiency

Stencil Technology
- surface roughness
- surface energy

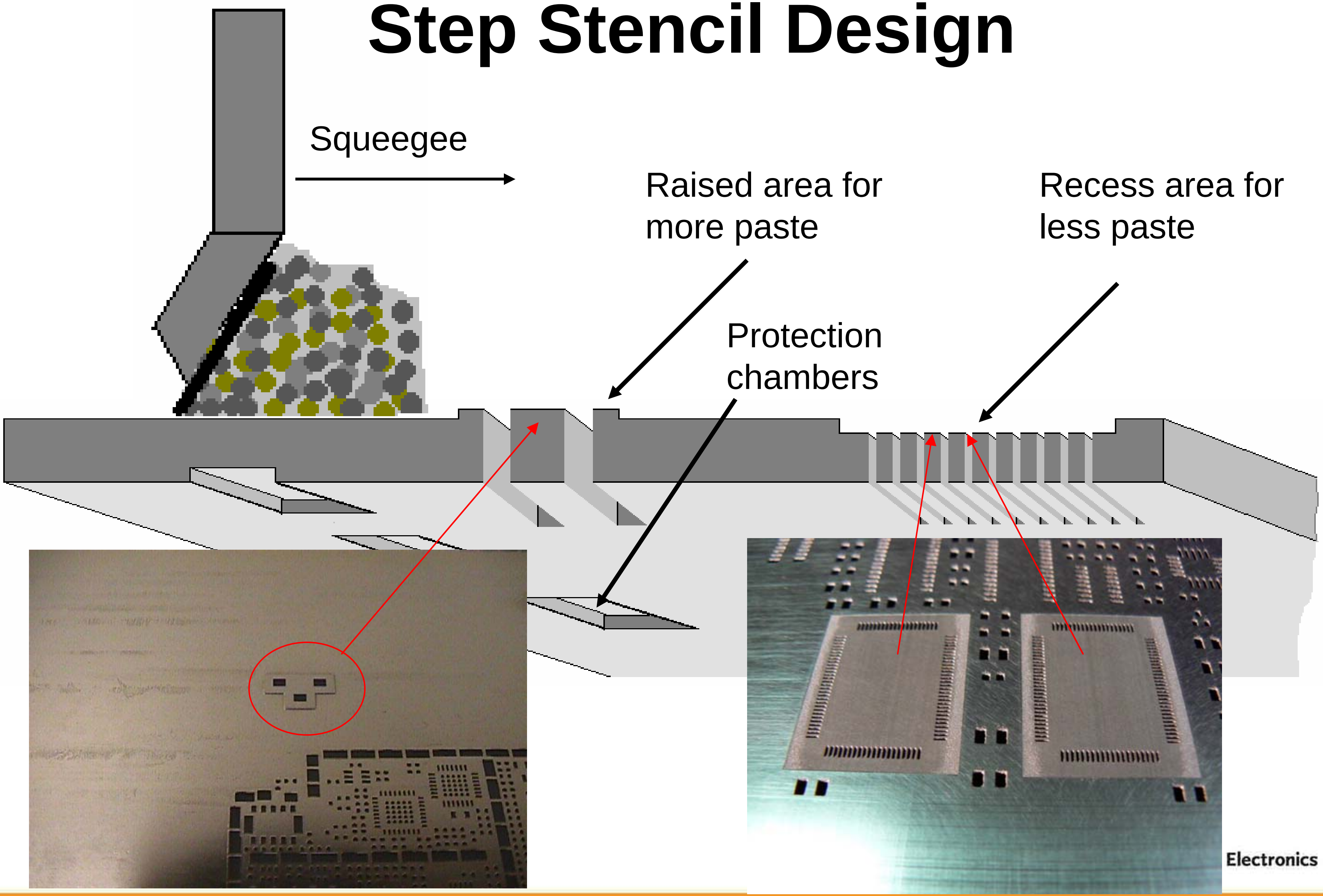
Paste Type
- Flux formulation
- Powder size

Printer Set-up
- Process settings
- Equipment stability

Other Significant Process Inputs

Step-Stencil Design Variability

Step Stencil Design



Squeegee

Raised area for more paste

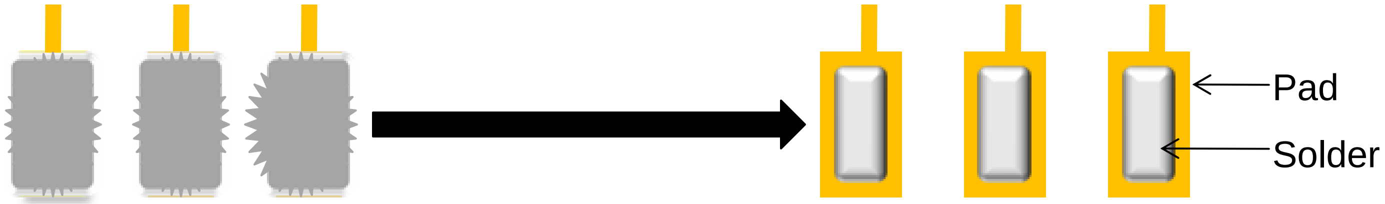
Protection chambers

Recess area for less paste

Electronics

Why Overprint?

- Over print larger components while keeping the small components 1:1 ratio
- Provides higher volume of paste for larger components
- Allows you to use one thickness stencil
- Allows one step printing



Over printed
green paste

Reflowed
good pullback

Detailed Cause and Effect

Fine Feature Printing

MATERIALS

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Flux
Chemistry
Activity Level
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Viscosity

Squeegee
Size & Shape of Edge
Material
Hardness
Length
Thickness
Angle of Blade
Rate of Wear

PERSONNEL & ENVIRONMENT

Handling
Procedures
Training
Discipline

Environment
Temperature
Humidity

Board
Pad Metallurgy
Cleanliness
Pad Geometry
Warpage
Planarity
Thickness
Mask Issues
Component Mix
Support
Pad Finish

Setup
Standard Procedures
Knead Parameters
Paste Storage
Stencil Storage
Paste Bead Diameter

GOOD PRINT

EQUIPMENT & TOOLING

Stencil
Taper
Material
Aperture Layout
Aperture Geometry
Aperture Size
Polish
Method of Fabrication
Thickness
Aspect Ratio
Area Ratio

Cleaning
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Frequency
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Procedures

Machine
Auto./ Semi Auto.
Alignment Accuracy
Serviceability
Repeatability
Maintenance Procedures
Ease of Operation
Set-up Time

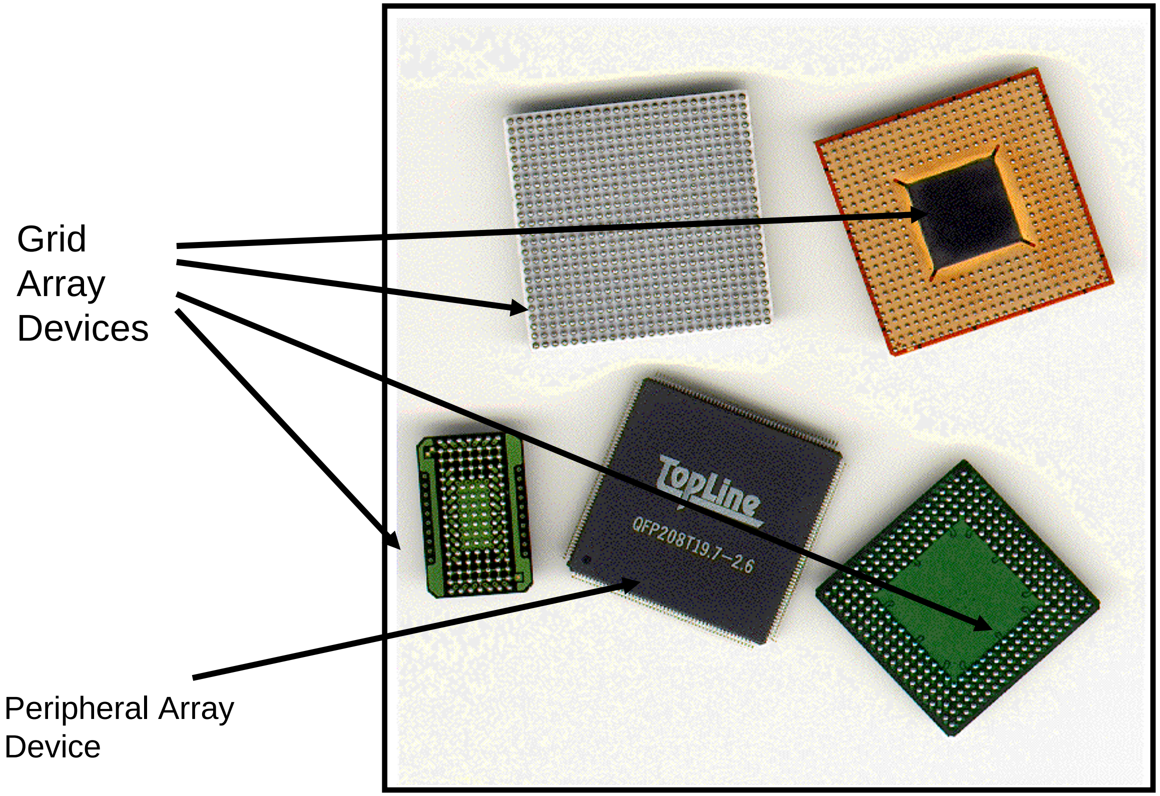
OPERATION & METRICS

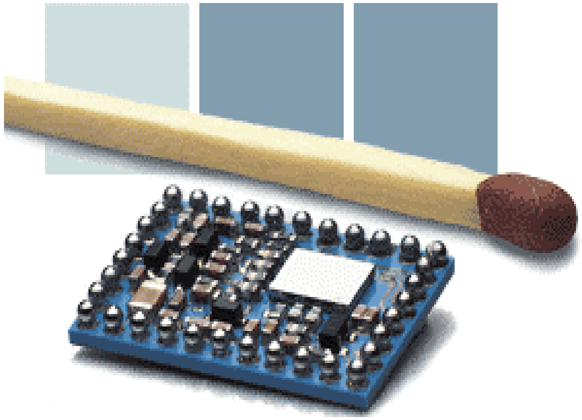
Metrology
Repeatability
Reproducibility

Process Control
Defect Data Collection
SPC Program
Continuous Improvement

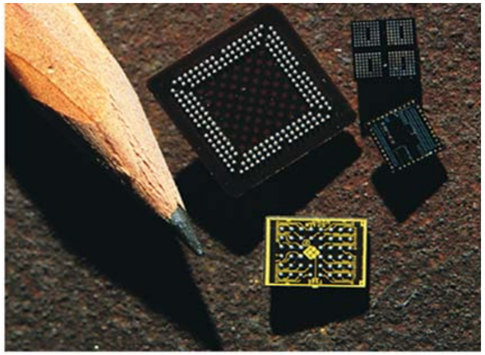
Process Parameters
Stroke Length
Print Speed
Frequency of Cleaning
Print Pressure
Print Gap
Separation Speed

Active Device Evolution





Bluetooth, MCM



µBGA, CCGA, COB, etc.

PLCC's → QFP's → BGA's → CSP's

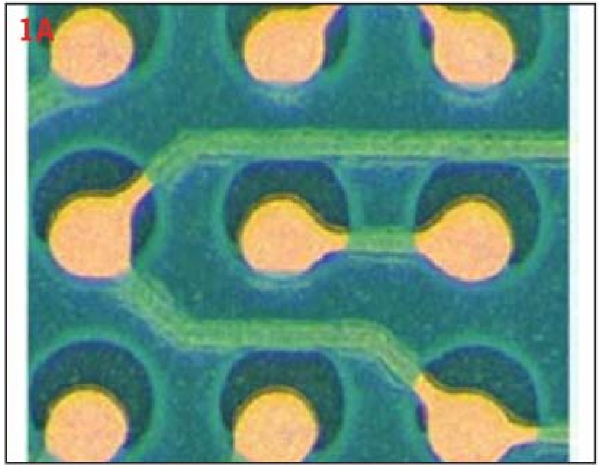
Fine Feature Printing – Key Inputs

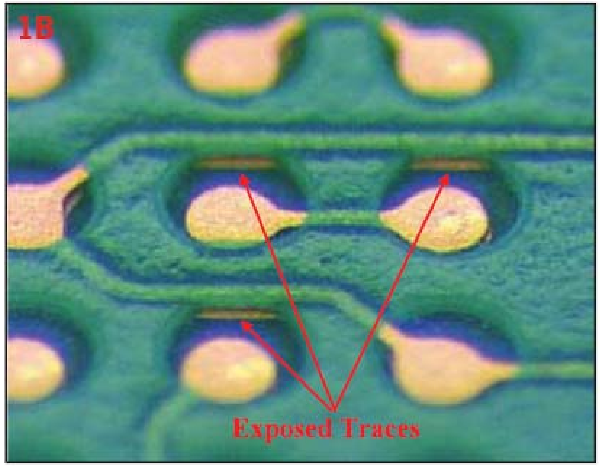
Boards

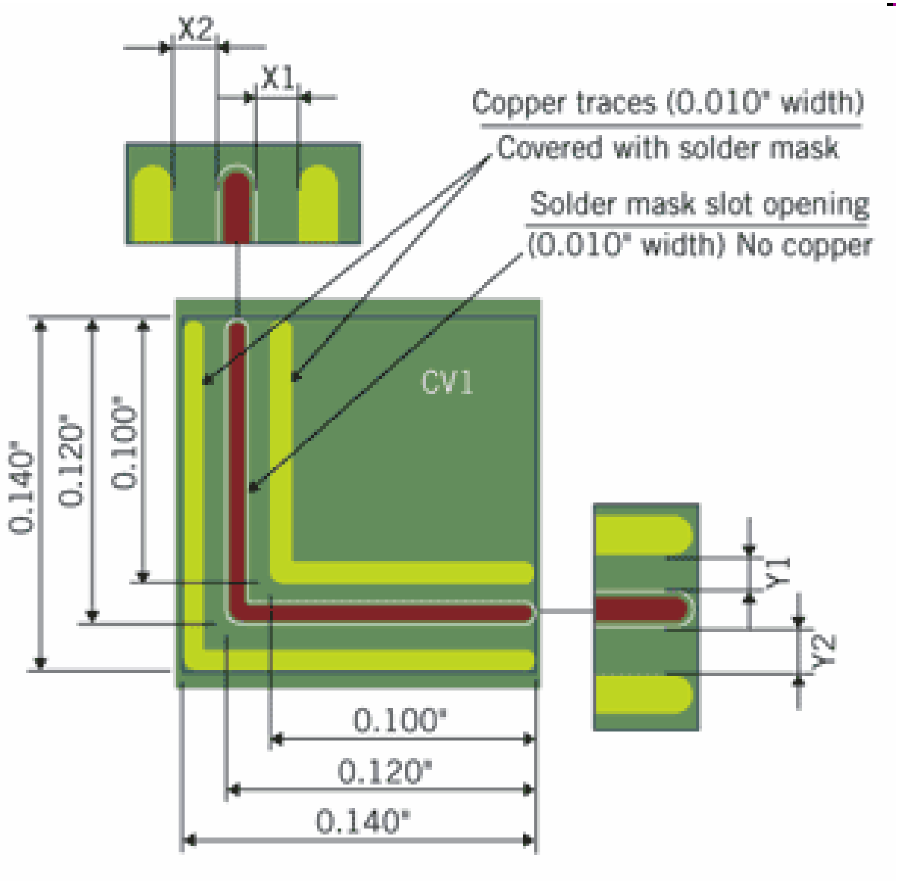
- Mask Registration and Design
  - Minimize MCSB
  - Prevent Shorts
  - Registration Tell Tale
- Over Etching
  - Increased Skips
- Alignment
  - Bridges/Shorts
- Ledged Ink - Gasket
- Mask Cure

Fine Feature Printing – Key Inputs

Mask Registration

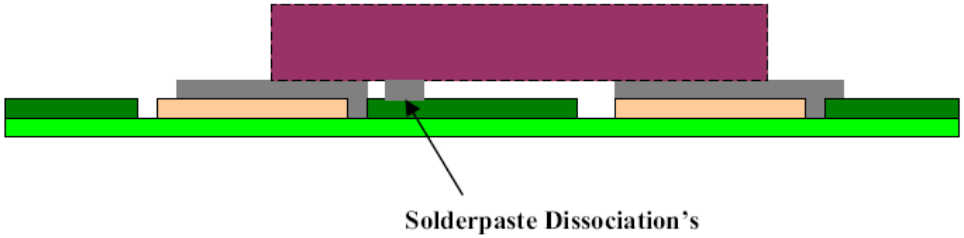


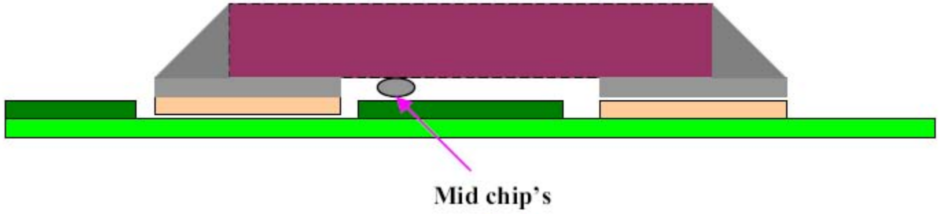


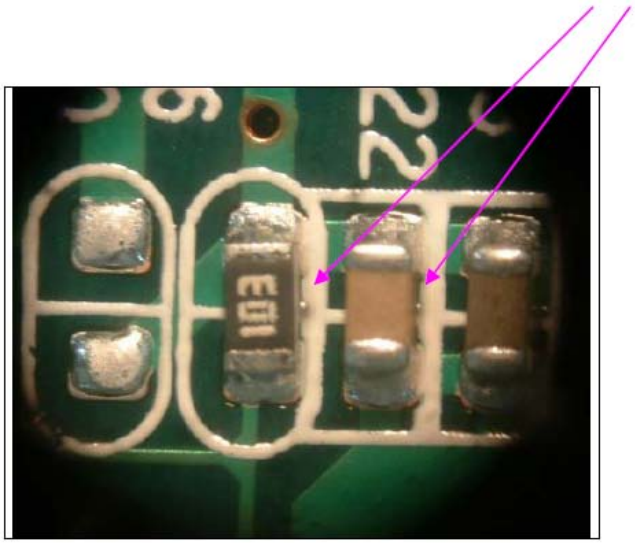


Photos and Figures from: Ly, H., Printed Circuits Design and Fab, January, 2009

Fine Feature Printing – Key Inputs



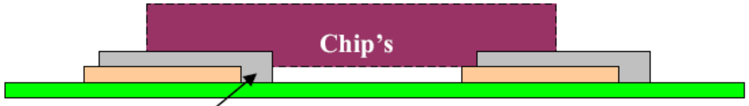




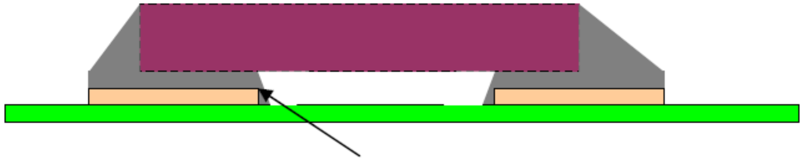
MCSB – Too Much Solder Paste and/or in the wrong location

- Mask Location – Keep Out
- Not Fully Cured Mask or Legend Ink can Contribute
- Rough Surface Better
- Alignment and Placement Pressure
- Reduce Foil Thickness

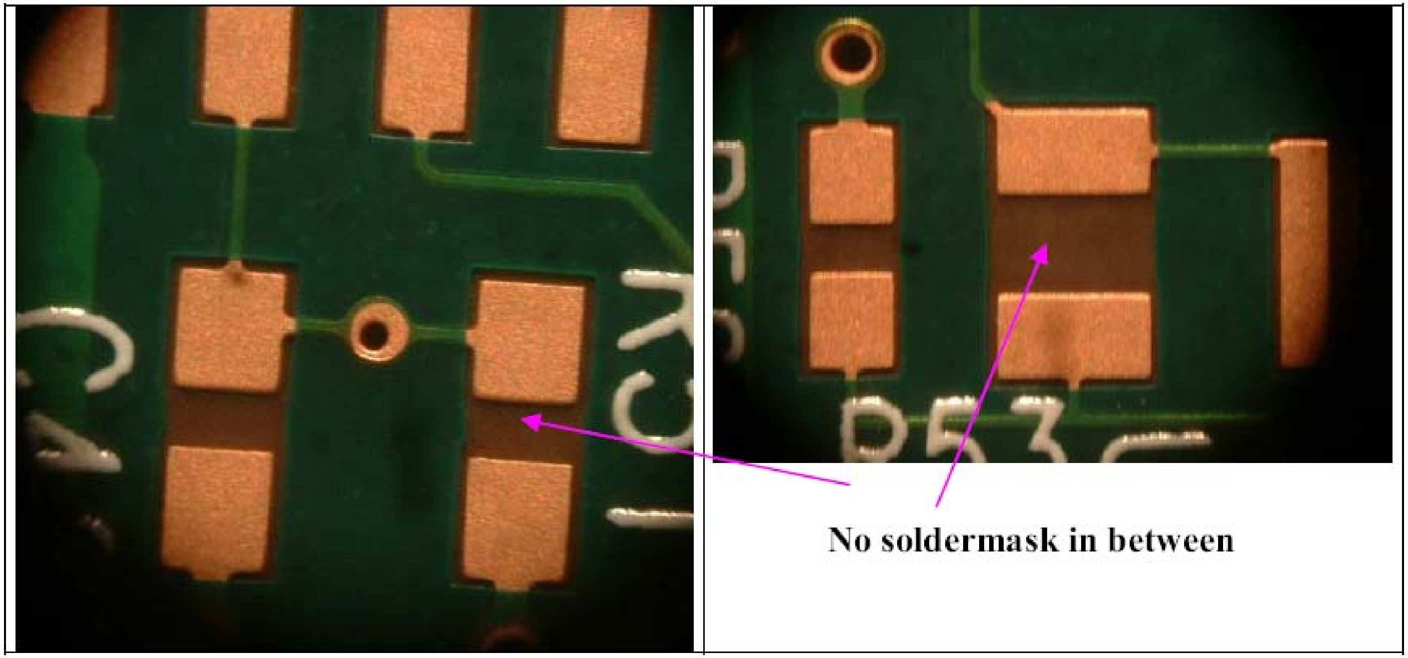
MCSB Mask Design



Miss alignment



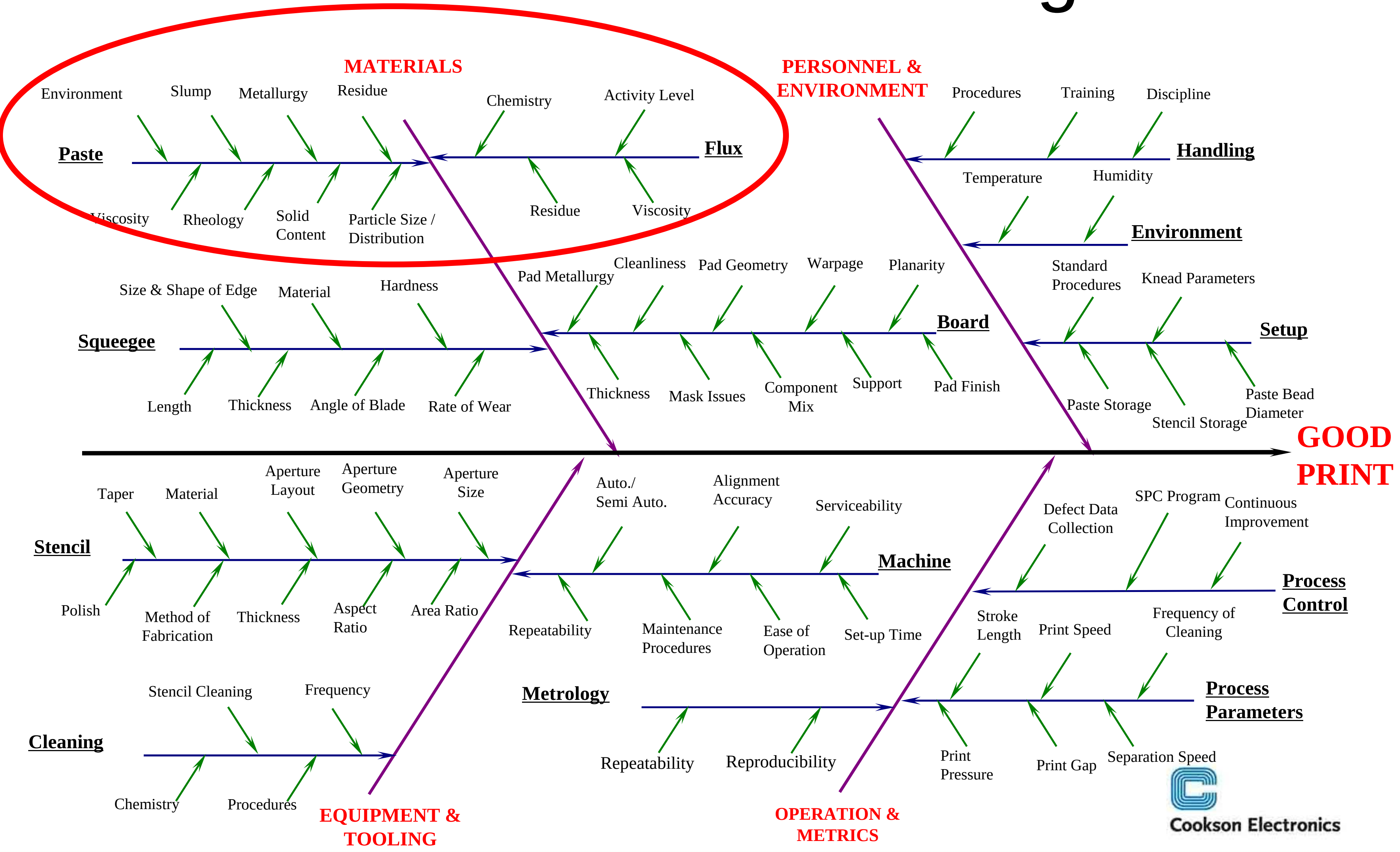
No dissociation during the liquidus… return to the pad



No soldermask in between

Detailed Cause and Effect

Fine Feature Printing



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Fine Feature Printing – Key Inputs

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FUNCTION OF PASTE INGREDIENTS

- METAL
  - – Melts & bonds to form connection
- FLUX SYSTEM
  - – Wets surfaces
  - – Cleans metal surface
  - – Conducts heat
- ACTIVATOR
  - – Oxide reduction
- ROSIN
  - – Tack - HT, Rheology
  - – Activator
- ADDITIVES
  - – Tack - LT, Release, Suspension, Smell, Detergent, Rheology
- SOLVENT
  - – Dissolve chemistry, Maintain Suspension

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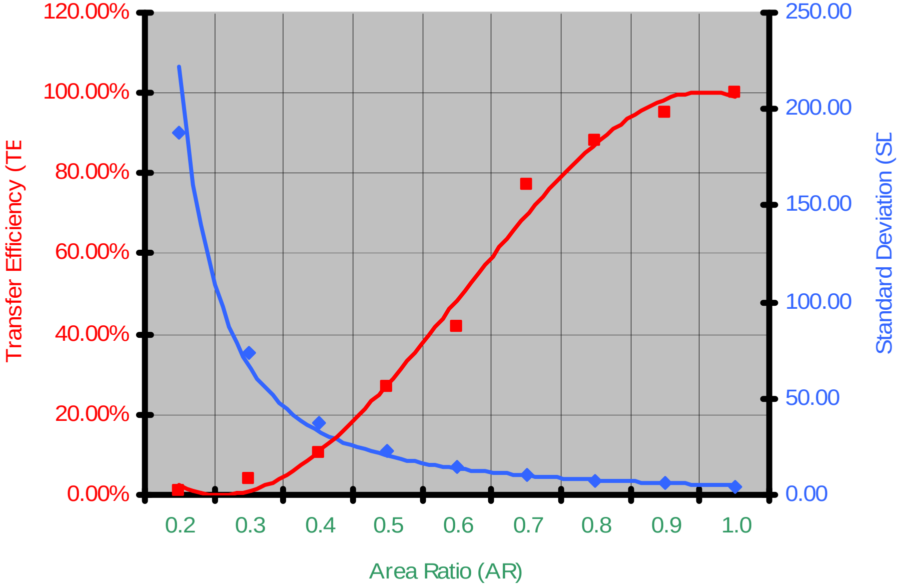
Science of Printing

AREA RATIO, and the effect of aperture wall smoothness on Area Ratio, is the primary factor that determines paste transfer



$$\text{Area Ratio} = \frac{\text{Aperture Opening Area}}{\text{Aperture Wall Area}}$$

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High Area Ratio

- Higher Paste Transfer
- High Transfer Efficiency
- Low Standard Deviation

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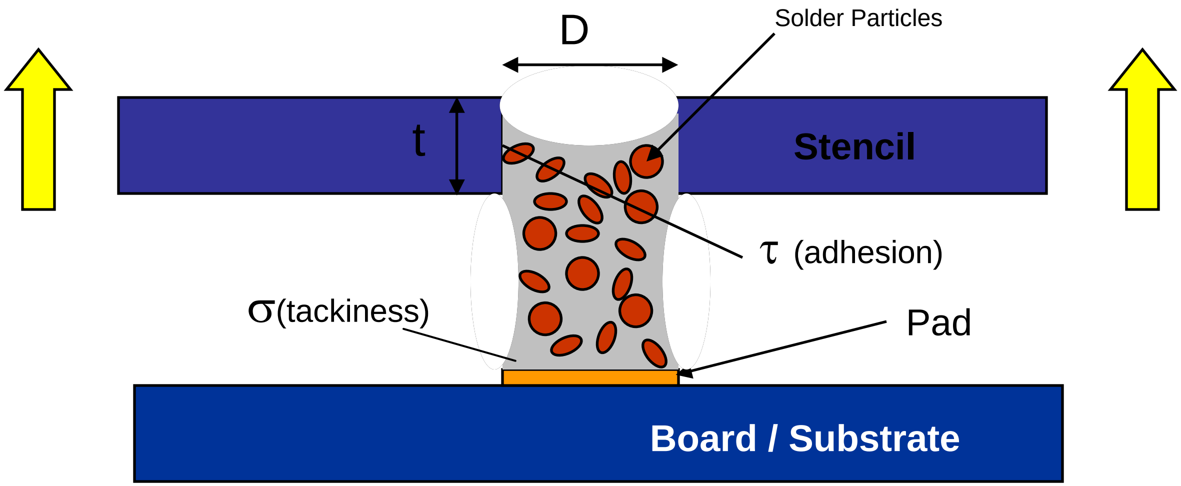
Problem Definition



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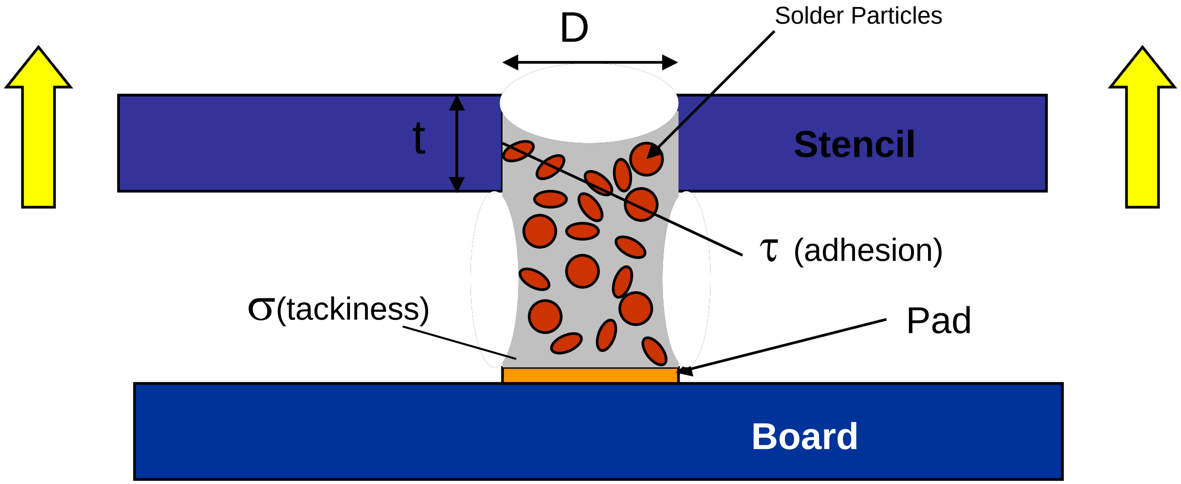

- These competing forces are determined by the Flux adhesion (and tack) on the two surfaces being separated.
- Transfer Efficiency can be predicted by the Area Ratio between the pad area and the stencil wall area.

Area Ratio and Transfer Efficiency

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$$\text{AR} = \frac{\textbf{Area of Circuit Side Opening}}{\textbf{Area of Aperture Walls}}$$

$$\text{TE} = 2.404 \times (\text{AR})^{3.426}$$

When AR gets small (below 1.0) the Adhesive forces compete with the Cohesive forces of the Solder Paste Rheology.

Increased Tack causes the Adhesive Forces to be greater than the Cohesive Forces and the paste tends to release from the Aperture mass, leaving the walls coated with paste.

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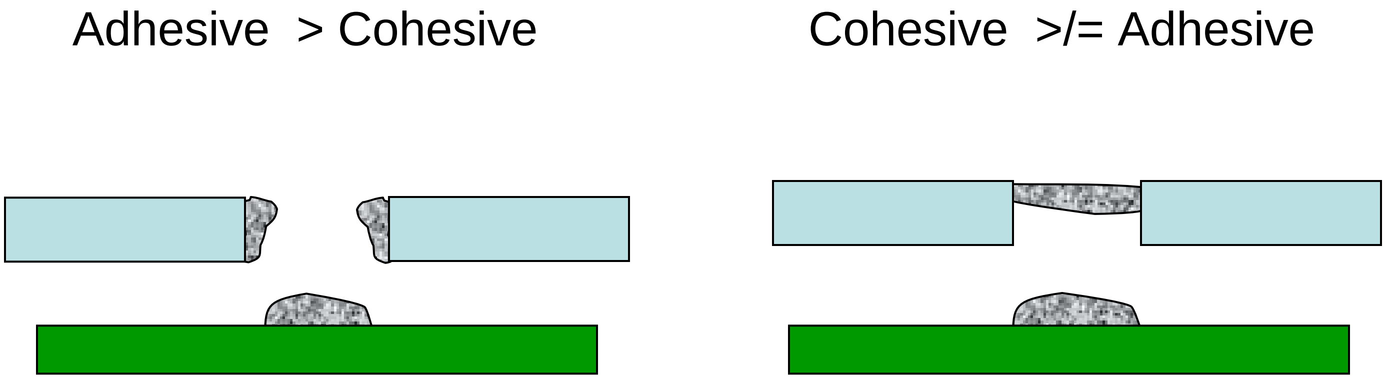
Area Ratio and Transfer Efficiency



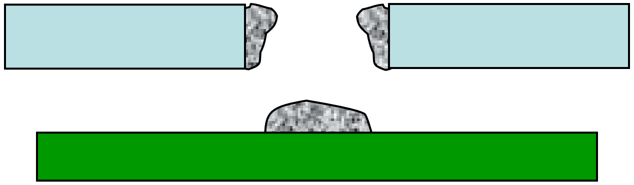
Two competing theories:

1. Increased Tack causes the Adhesive Forces to be greater than the Cohesive Forces and the paste tends to release from the Aperture mass, leaving the walls coated with paste.

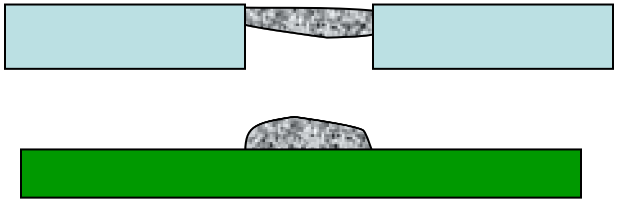
2. Cohesive Forces are equal to or greater than Adhesive Forces and the paste partially releases from the wall.

Area Ratio and Transfer Efficiency

Adhesive > Cohesive



Cohesive >/= Adhesive



Two competing theories:

Observations seem to favor Theory 1

Question still remains as to the effect of grain structure and surface lubricity on TE at various Area Ratios. Does a different surface condition extend the ability of the paste to completely vacate the aperture, as we observe at AR above 1.0?

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Solder Paste Particle Size
Mils

Type 3	Type 4	Type 5
0.98-1.77	0.79-1.50	.59-0.98
1.38	1.15	0.79

Type 6	Type 7
0.20-0.59	.008-0.43
.39	0.26

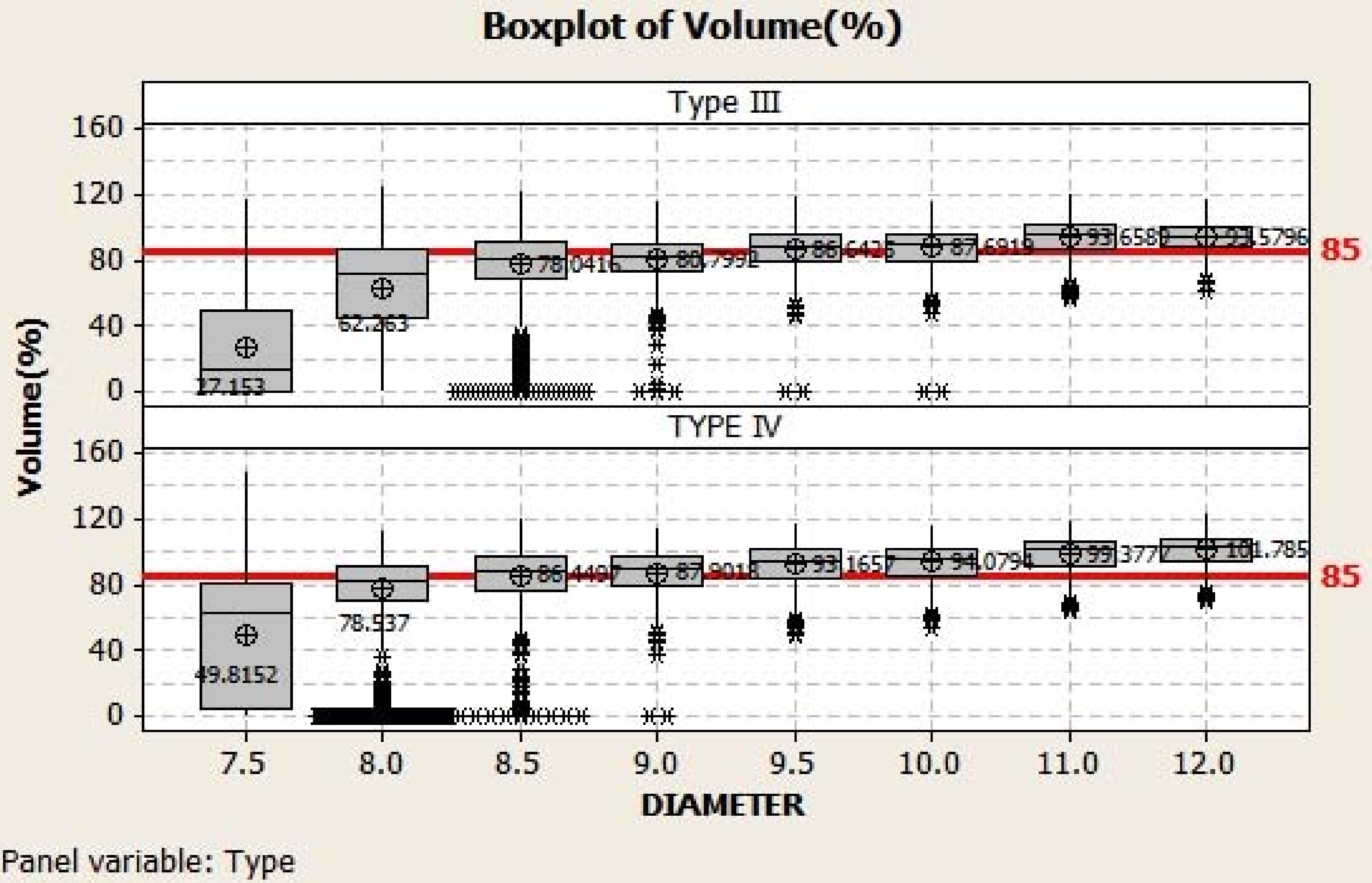
Particle Size Guidelines

J-STD-005 Specification				
Type	None larger than (µm):	Maximum 1% particles by weight larger than (µm):	Minimum 80% particles by weight between (µm):	Maximum 10% particles by weight smaller than (µm):
T1	160	150	150-75	20
T2	80	75	75-45	20
T3	50	45	45-25	20
T4	40	38	38-20 (90%)	20
T5	30	25	25-15 (90%)	15
T6	20	15	15-5 (90%)	5

Average Powder in um)		**Min Aperture Width in um (x5)**	
35	1.4 mils	**175**	6.9 mils
29	1.1 mils	**145**	5.7 mils
20	0.8 mils	**100**	3.9 mils
10		**50**	

Solder Paste Particle Size Comparison

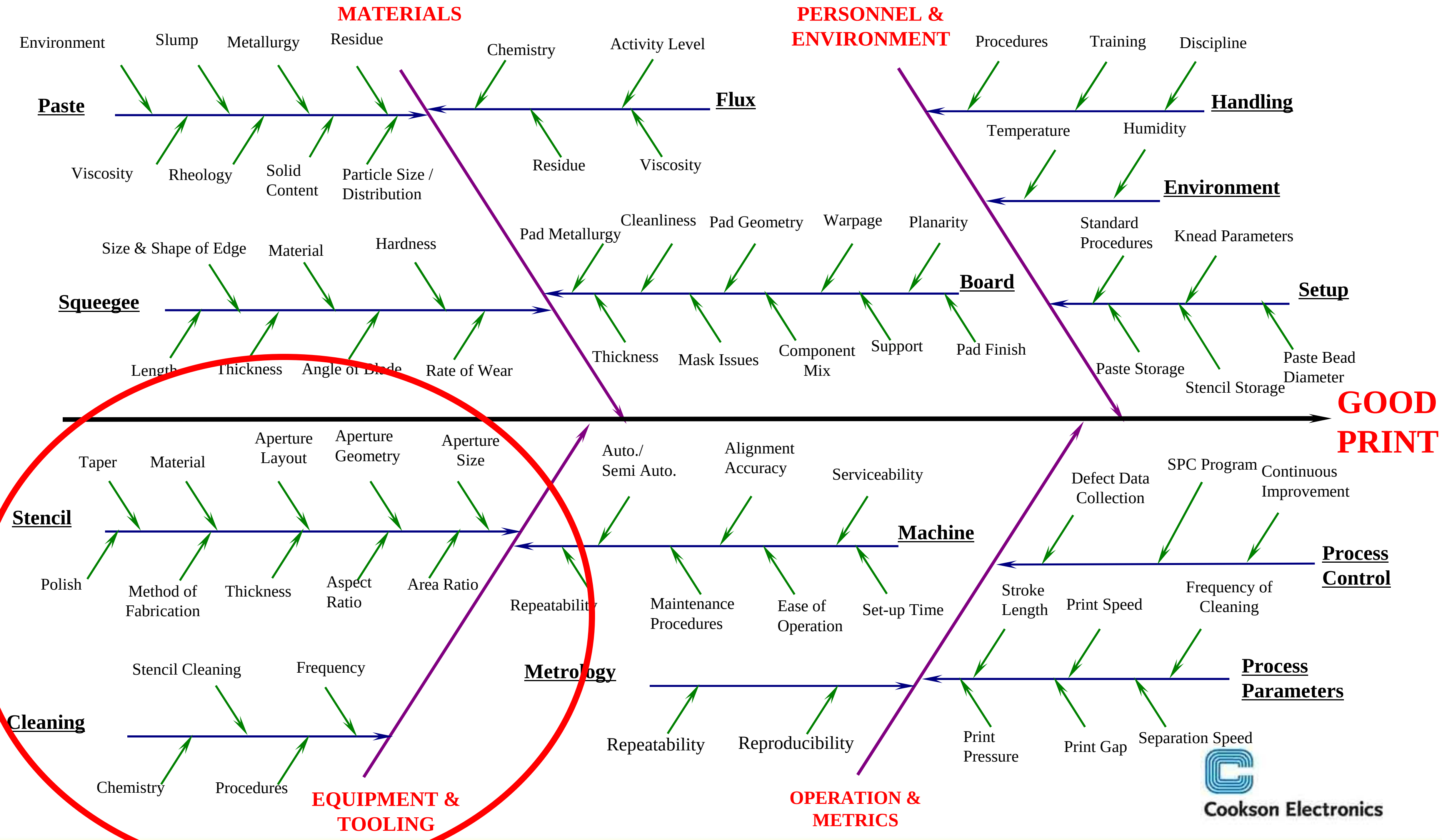
alpha



Detailed Cause and Effect

alpha

Fine Feature Printing



MATERIALS

Paste
Environment
Slump
Metallurgy
Residue
Viscosity
Rheology
Solid Content
Particle Size / Distribution

Flux
Chemistry
Activity Level
Residue
Viscosity

Squeegee
Size & Shape of Edge
Material
Hardness
Length
Thickness
Angle of Blade
Rate of Wear

Board
Pad Metallurgy
Cleanliness
Pad Geometry
Warpage
Planarity
Thickness
Mask Issues
Component Mix
Support
Pad Finish

PERSONNEL & ENVIRONMENT

Handling
Procedures
Training
Discipline

Environment
Temperature
Humidity

Setup
Standard Procedures
Knead Parameters
Paste Storage
Stencil Storage
Paste Bead Diameter

GOOD PRINT

EQUIPMENT & TOOLING

Stencil
Taper
Material
Aperture Layout
Aperture Geometry
Aperture Size
Polish
Method of Fabrication
Thickness
Aspect Ratio
Area Ratio

Cleaning
Stencil Cleaning
Frequency
Chemistry
Procedures

Machine
Auto./ Semi Auto.
Alignment Accuracy
Serviceability
Repeatability
Maintenance Procedures
Ease of Operation
Set-up Time

Metrology
Repeatability
Reproducibility

OPERATION & METRICS

Process Control
Defect Data Collection
SPC Program
Continuous Improvement

Process Parameters
Stroke Length
Print Speed
Frequency of Cleaning
Print Pressure
Print Gap
Separation Speed

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alpha

PoP / Fine Pitch Assembly Trends

April 25, 2012

SMTA
Surface Mount Technology Association

Portland Oregon Chapter

Cookson Electronics

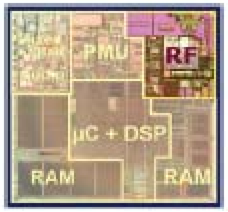
Mobile Device & Tablet Trends

Device Type	Feature Phone		
Year	2011	2013	2016
Unit Shipments (MM)	700	590	480
Board Size	4x8	4x5	4x5
Component Count	400	350	300
Component Types	0201/ WLP	0201/ WLP	01005/ WLP
Pitch (mm)	0.4	0.4	0.35
I/Os	450	750	900+

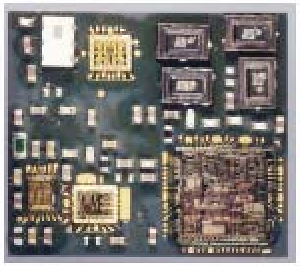
- **Low end phone construction simplifying**
- **Smart phone feature size decreasing: Increased difficulty of assembly**

Key Drivers for Fine Feature

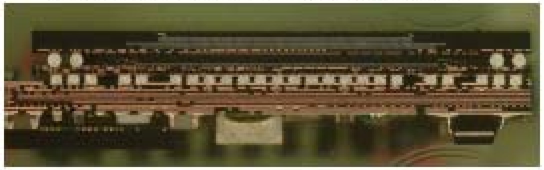
- Increased functionality
- System on Chip
  - Most functions on one die



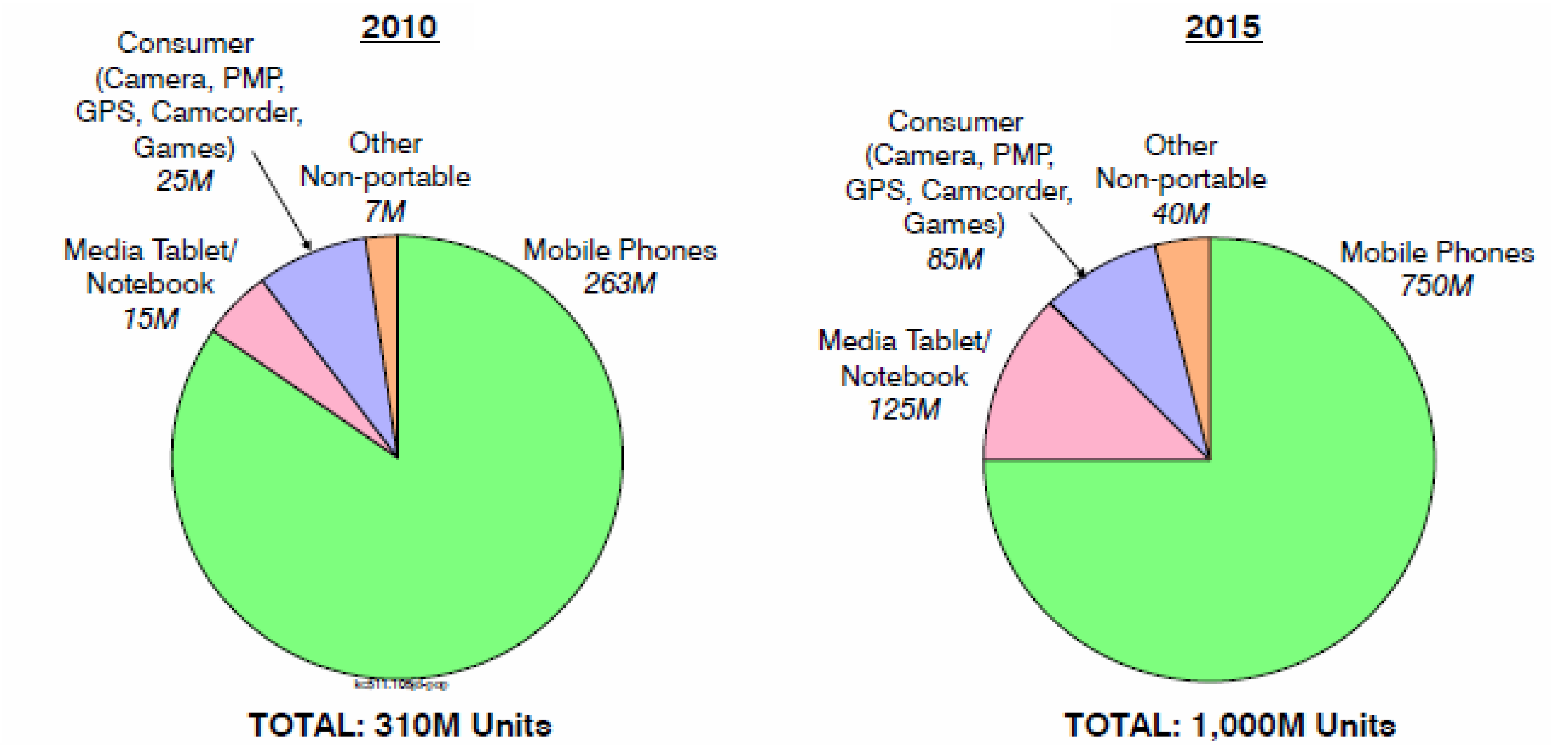
- System in Package
  - Active and Passive on one package

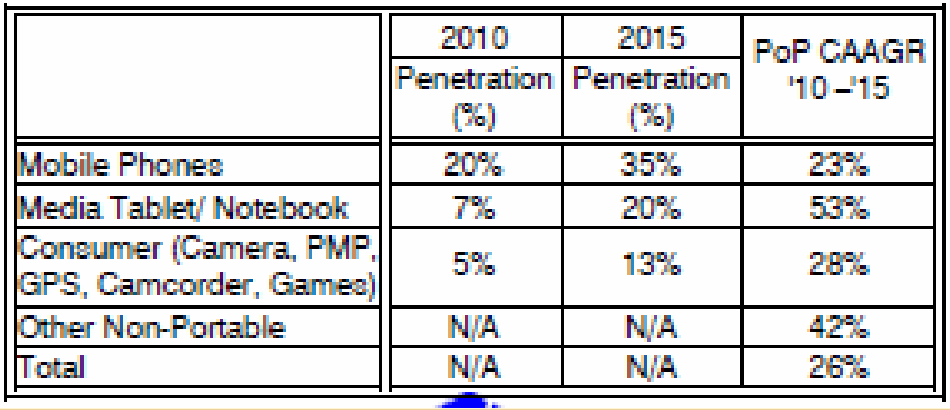


- 3D packaging
  - Multiple die stacked in one package
  - PoP (Logic and Memory)



Package on Package Trends



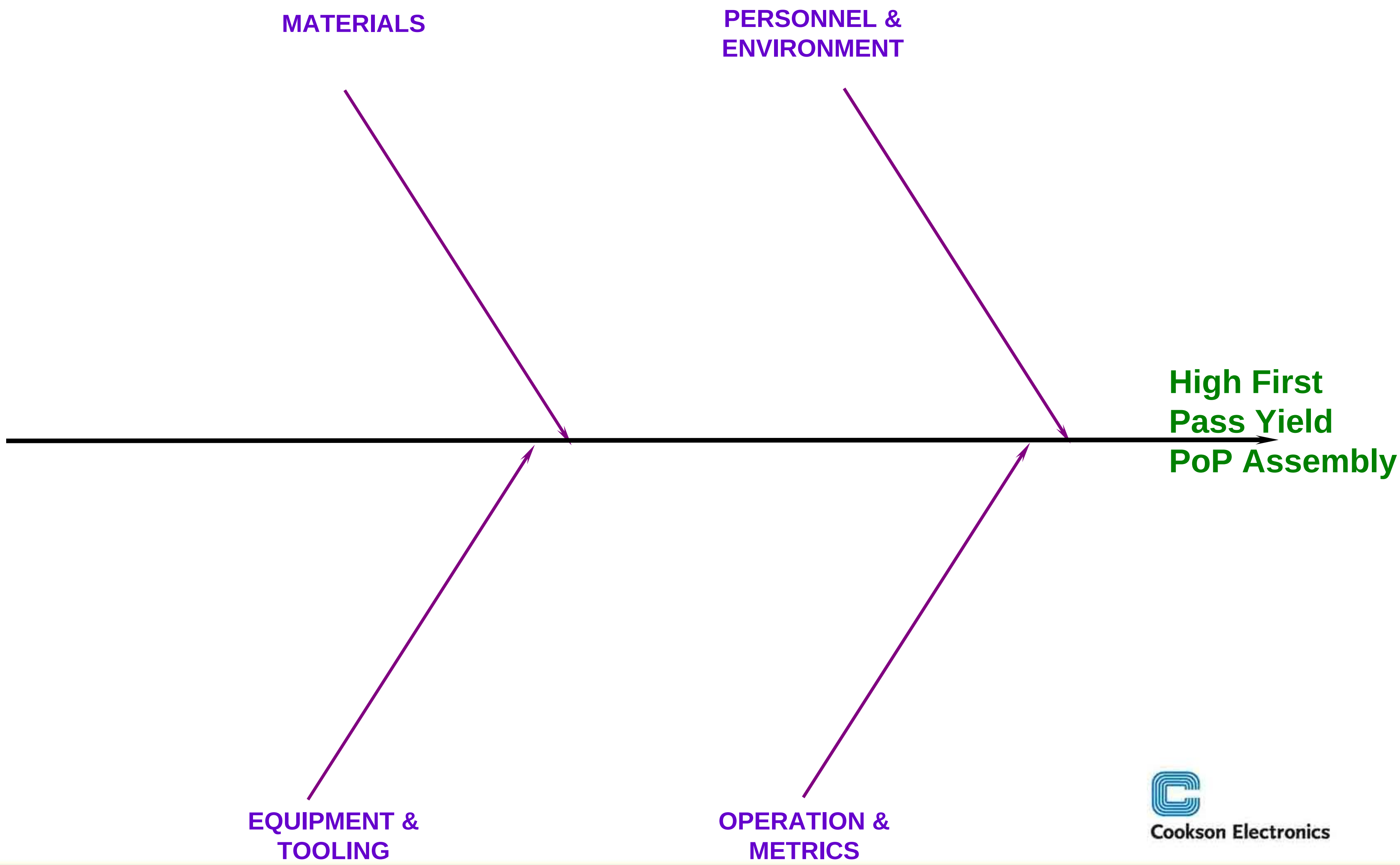


	2010 Penetration (%)	2015 Penetration (%)	PoP CAAGR '10 –'15
Mobile Phones	20%	35%	23%
Media Tablet/ Notebook	7%	20%	53%
Consumer (Camera, PMP, GPS, Camcorder, Games)	5%	13%	28%
Other Non-Portable	N/A	N/A	42%
Total	N/A	N/A	26%

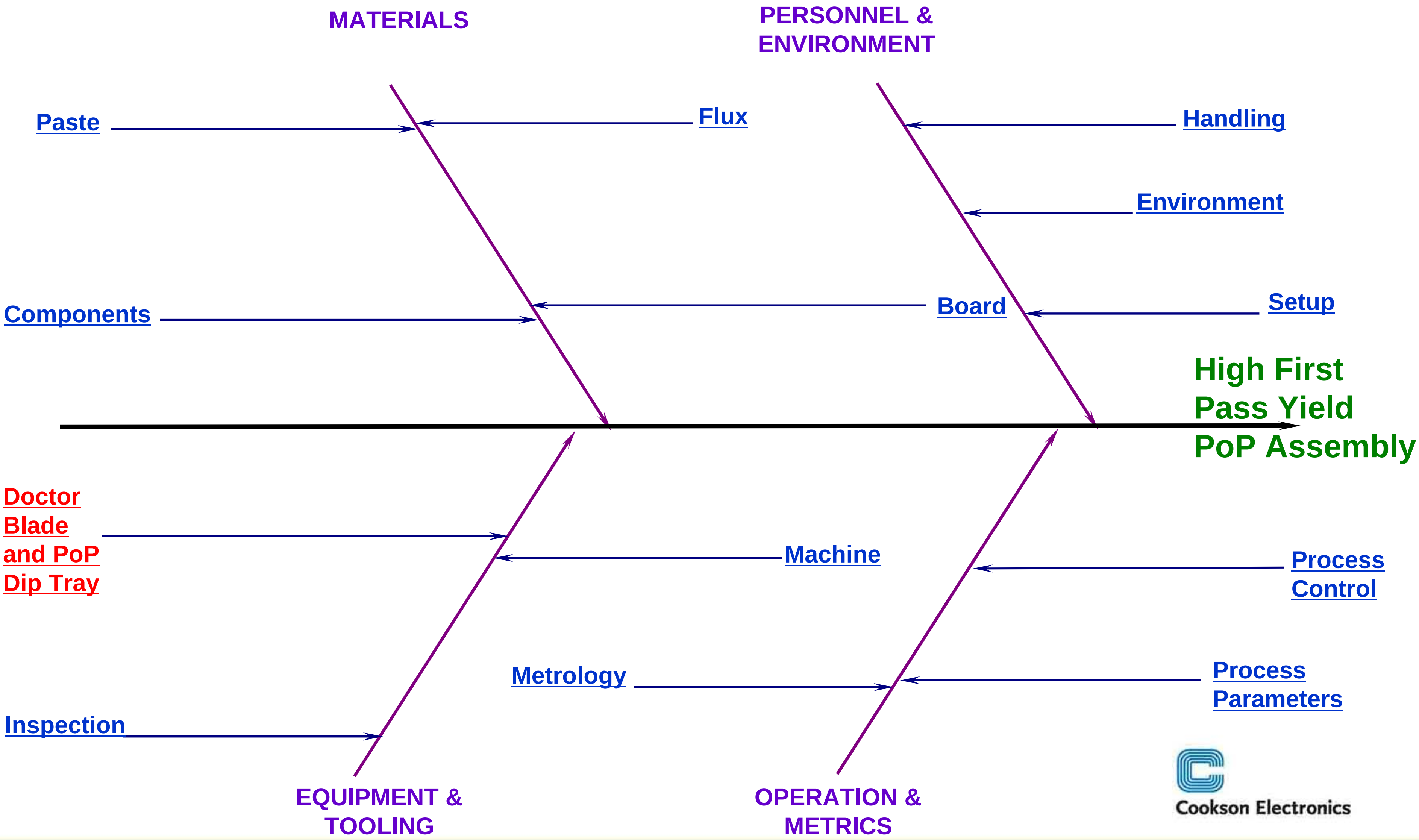
PoP Joining Options

- Depending on pitch, bottom package (0.4 mm pitch) can either be printed or dipped
- Top package (0.5 mm pitch), can use either paste flux or paste
  - Many customer now using paste flux
  - Especially if bottom package is TMV with spheres
- Sphere alloy – SAC125 + Ni (LF35)
- ALPHA Offering:
  - PoP33 – T5 powder
  - PoP34 – T6 powder

Construction of the PoP Fishbone Analysis



PoP Fishbone



MATERIALS

Paste

Flux

Components

PERSONNEL & ENVIRONMENT

Handling

Environment

Board

Setup

High First Pass Yield PoP Assembly

Doctor Blade and PoP Dip Tray

Machine

Metrology

Inspection

EQUIPMENT & TOOLING

Process Control

Process Parameters

OPERATION & METRICS

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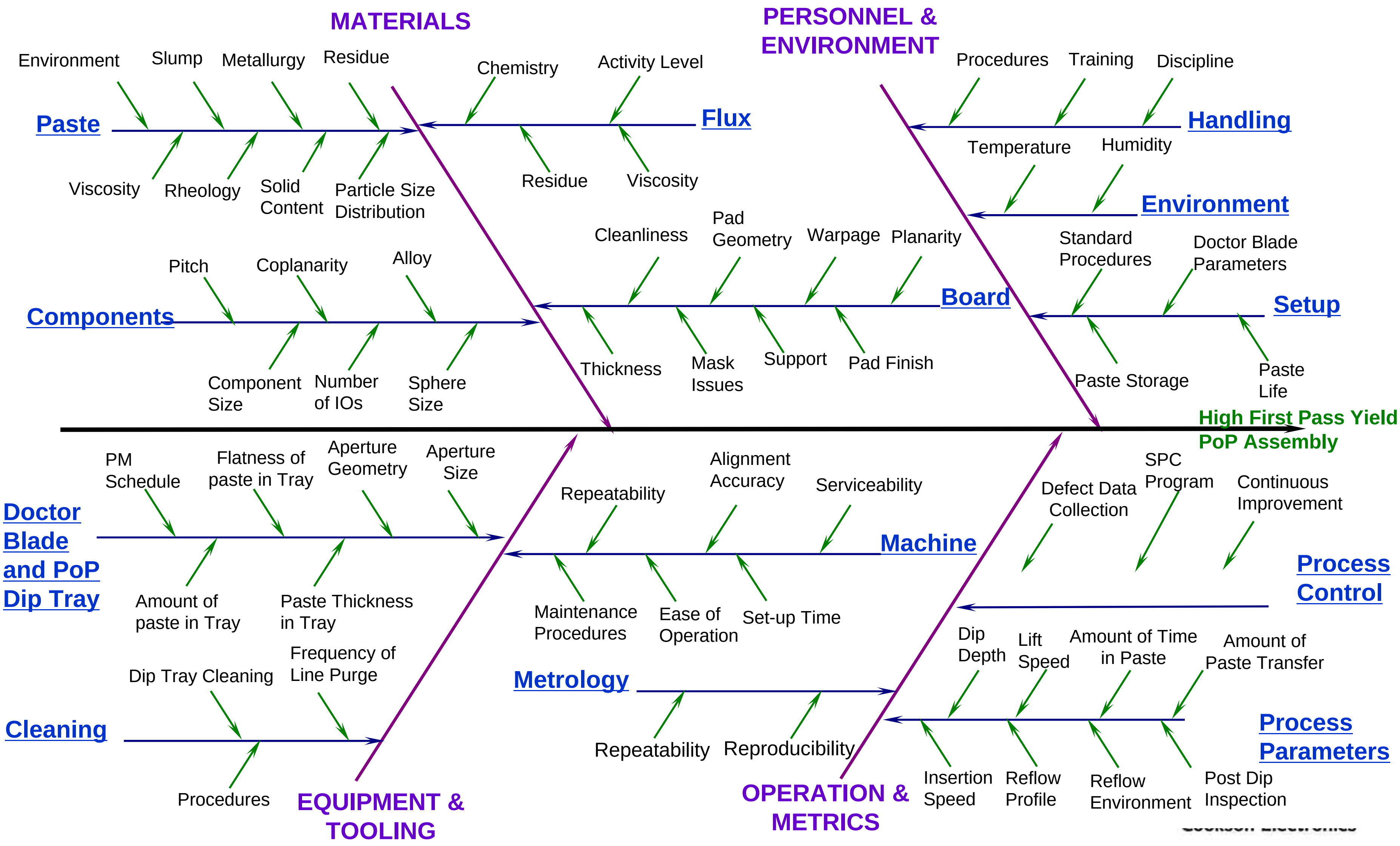
PoP Fishbone



MATERIALS

- **Paste**
  - Environment
  - Slump
  - Metallurgy
  - Residue
  - Viscosity
  - Rheology
  - Solid Content
  - Particle Size Distribution
- **Flux**
  - Chemistry
  - Activity Level
  - Residue
  - Viscosity
- **Components**
  - Pitch
  - Coplanarity
  - Alloy
  - Component Size
  - Number of IOs
  - Sphere Size
- **Board**
  - Cleanliness
  - Pad Geometry
  - Warpage
  - Planarity
  - Thickness
  - Mask Issues
  - Support
  - Pad Finish

PERSONNEL & ENVIRONMENT

- **Handling**
  - Procedures
  - Training
  - Discipline
- **Environment**
  - Temperature
  - Humidity
- **Setup**
  - Standard Procedures
  - Doctor Blade Parameters
  - Paste Storage
  - Paste Life

High First Pass Yield PoP Assembly

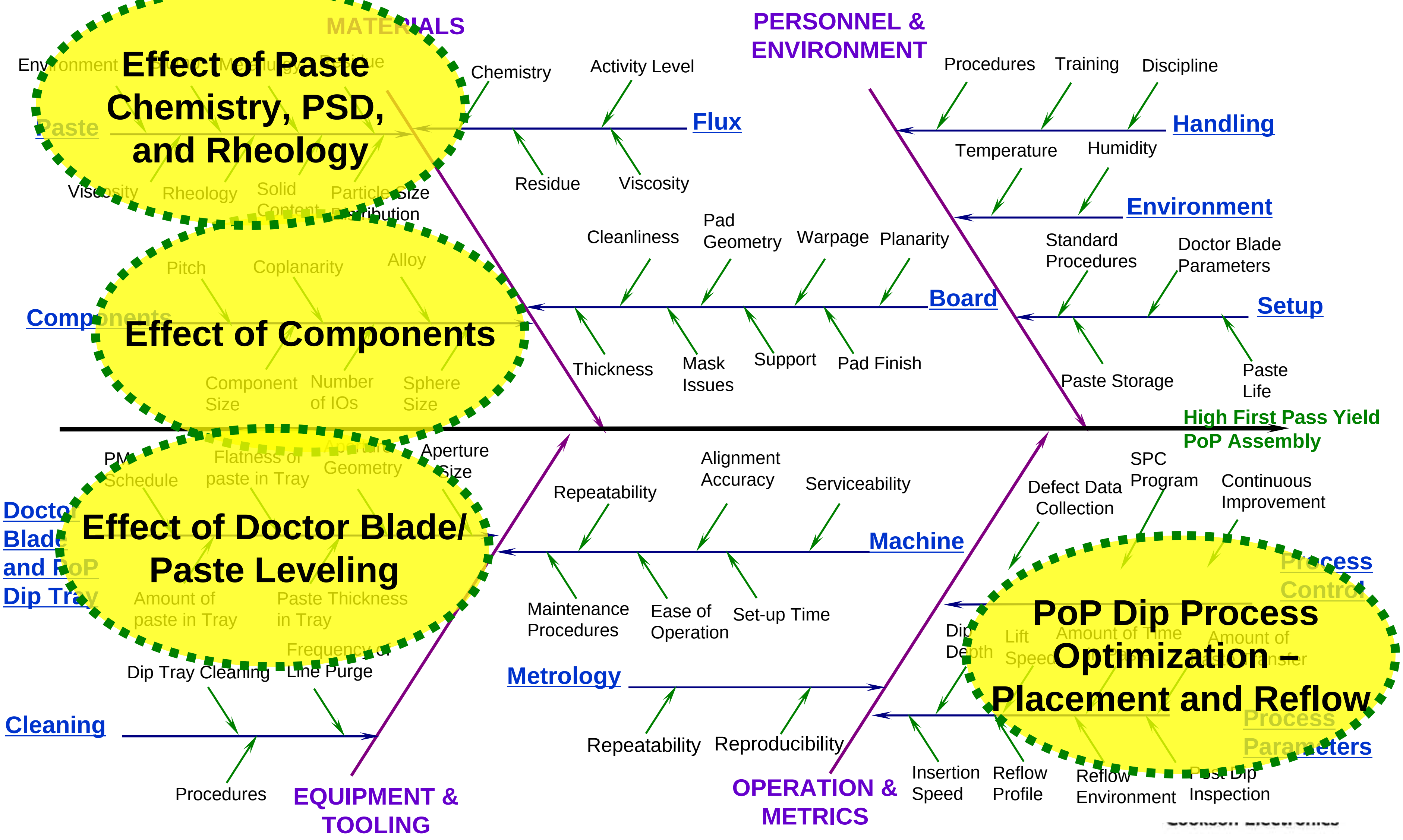
EQUIPMENT & TOOLING

- **Doctor Blade and PoP Dip Tray**
  - PM Schedule
  - Flatness of paste in Tray
  - Aperture Geometry
  - Aperture Size
  - Amount of paste in Tray
  - Paste Thickness in Tray
- **Machine**
  - Repeatability
  - Alignment Accuracy
  - Serviceability
  - Maintenance Procedures
  - Ease of Operation
  - Set-up Time
- **Cleaning**
  - Dip Tray Cleaning
  - Frequency of Line Purge
  - Procedures

OPERATION & METRICS

- **Process Control**
  - Defect Data Collection
  - SPC Program
  - Continuous Improvement
- **Metrology**
  - Repeatability
  - Reproducibility
- **Process Parameters**
  - Dip Depth
  - Lift Speed
  - Amount of Time in Paste
  - Amount of Paste Transfer
  - Insertion Speed
  - Reflow Profile
  - Reflow Environment
  - Post Dip Inspection

PoP Fishbone



Effect of Paste Chemistry, PSD, and Rheology

Effect of Components

Effect of Doctor Blade/ Paste Leveling

PoP Dip Process Optimization – Placement and Reflow

Issues Specific to Optimized PoP Process

- BGA warpage signature
- Component size
- BGA oxidation level
- Reflow Profile
- Reflow environment

- Paste Rheology
- Determining minimum paste transfer
- Inspection of component post dip

PoP Joining Options

- Depending on pitch, bottom package (0.4 mm pitch) can either be printed or dipped
- Top package (0.5 mm pitch), can use either paste flux or paste
  - Many customer now using dip flux
  - Especially if bottom package is TMV with spheres
- Sphere alloy – SAC125 + Ni (LF35)
- ALPHA Offering:
  - PoP33 – T5 powder
  - PoP34 – T6 powder

The Dip Transfer Process

- Two material routes are possible
  - A gel flux (tacky flux) system
  - A low viscosity solder paste system

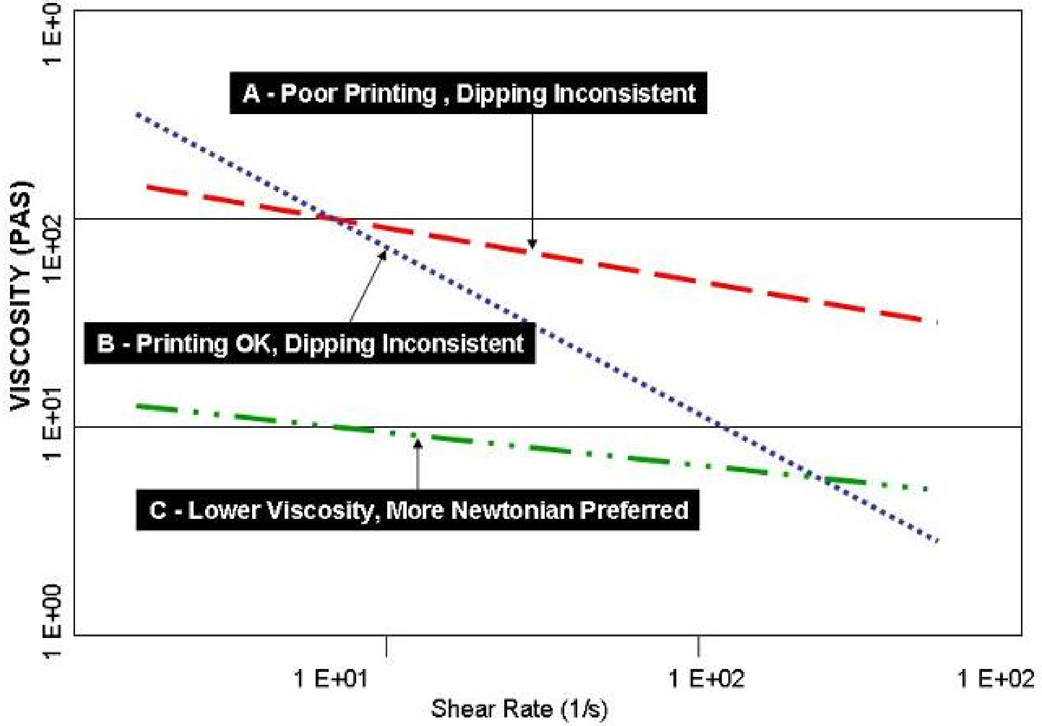
- In Both cases the material must provide
  1. Consistent transfer volume in the dip process
  2. Enough tack/shear resistance to hold the component in place
  3. Adequate soldering capability to ensure defect free connection from the upper to the lower package
  4. Stable rheology over time

Characterising Rheology For The Dip Transfer Process

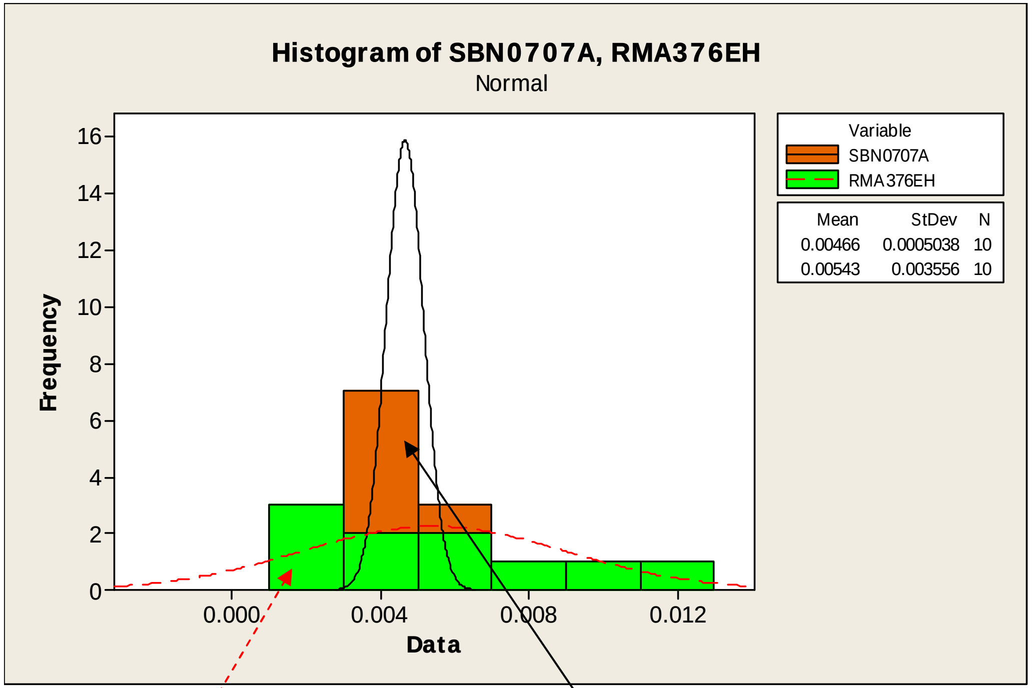
Material A : ** Poor printing (insufficient shear thinning) ***and* inconsistent dip transfer consistency (too high starting viscosity/tack)

Material B : ** Printing OK (sufficient shear thinning ***but* inconsistent dip transfer consistency (of too high starting viscosity/tack)

Material C : ** Good printing (lower viscosity/tack) and dip transfer consistency (lower viscosity/tack) – ***Preferred Rheological Profile*



Characterising Dip Transfer Weight



High Viscosity, High Tack Material

Lower Viscosity More Newtonian Material

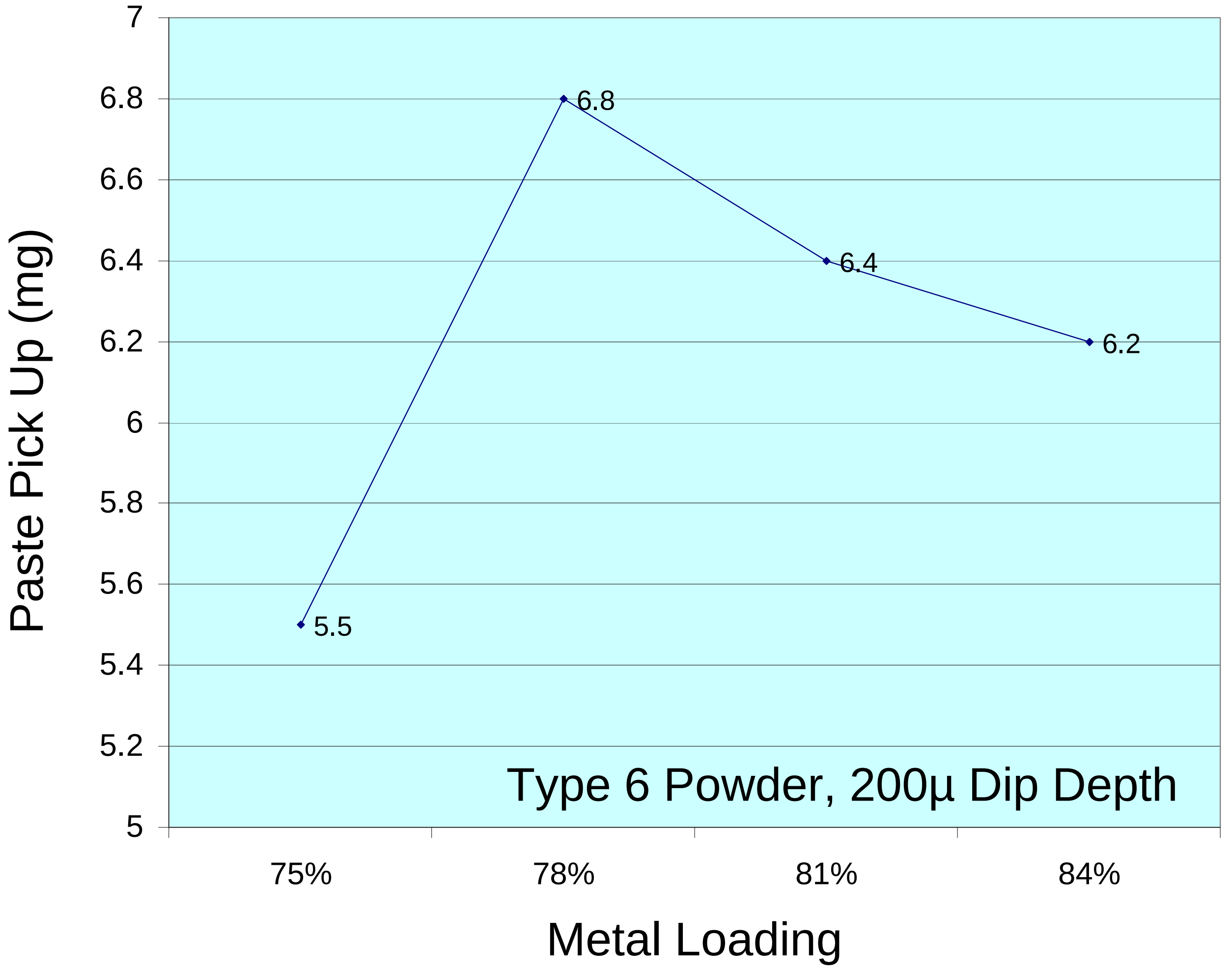
- **BGA256; 400 µm ball dipped into a 200 µm fixed thickness of flux material for 0.5 seconds**
- **Weighed on a high accuracy scale measuring to 0.0001g**
- **Results show that high tack, high viscosity materials give highly variable results (Material A).**

Key Solder Paste Variables

Metal Loading (% by Weight)

Solder Powder Particle Size Distribution

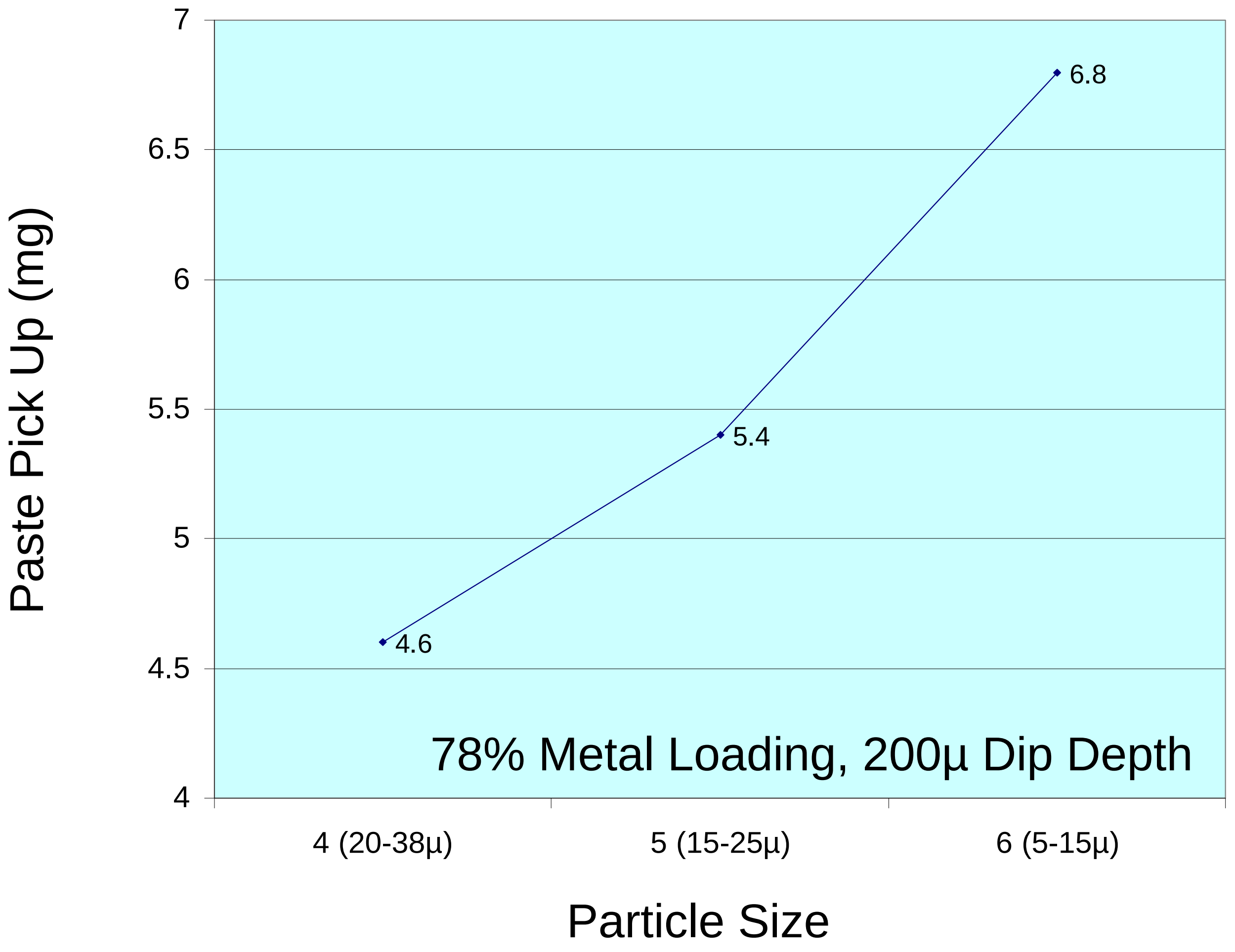
Metal Loading Optimization



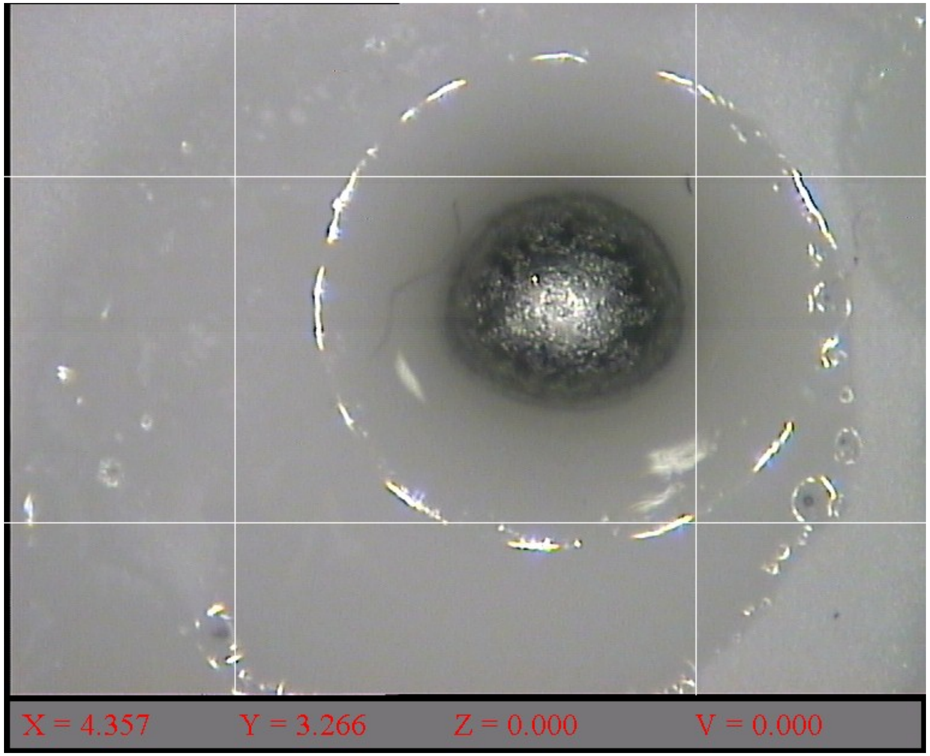
Particle Size Distribution

J-STD-005				
Type	None larger than (μm):	Maximum 1% particles by weight larger than (μm):	Minimum 80% particles by weight between (μm):	Maximum 10% particles by weight smaller than (μm):
T2	80	75	75-45	20
T3	50	45	45-25	20
T4	40	38	38-20 (90%)	20
T5	30	25	25-15 (90%)	15
T6	20	15	15-5 (90%)	5

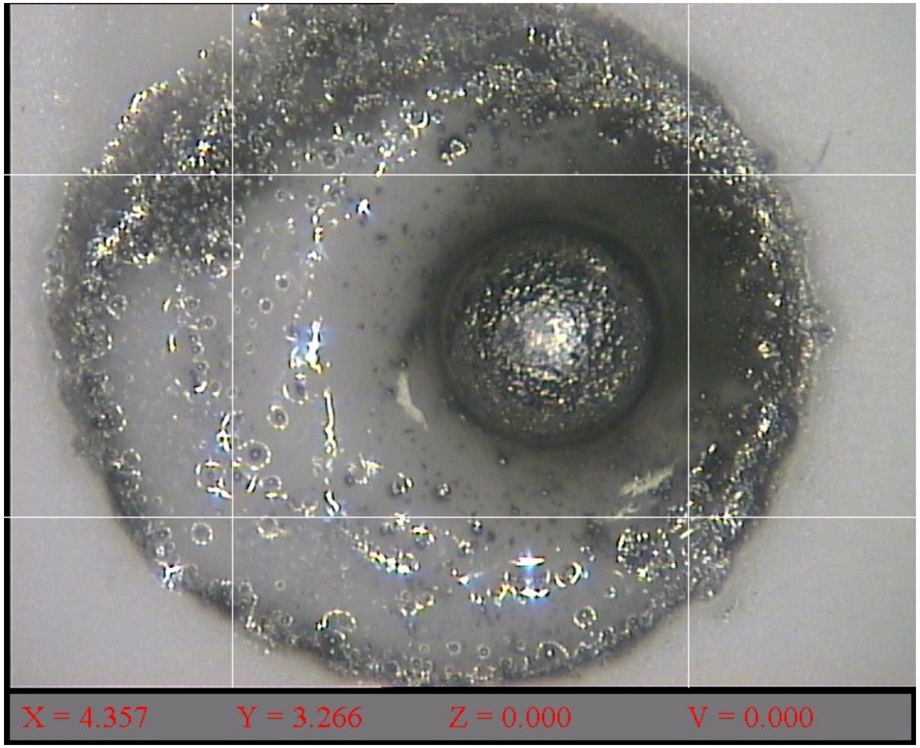
Particle Size Distribution



PoP33 Reflow Yield vs. Powder Size



Type 5 Powder

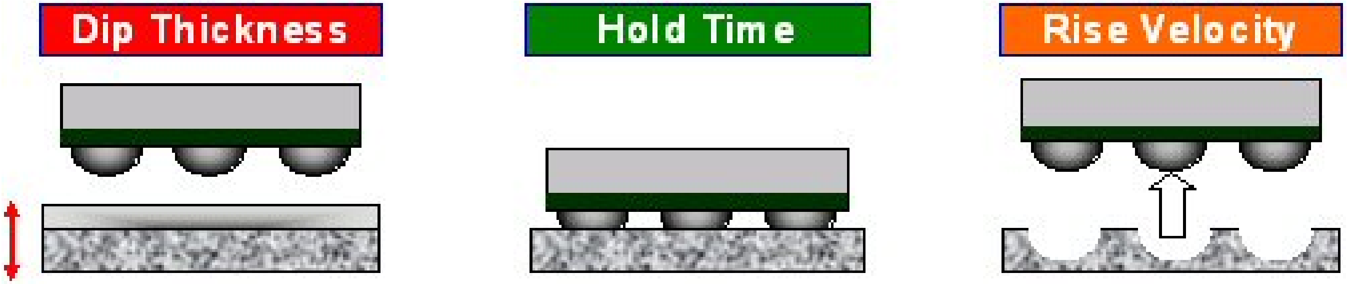


Type 6 Powder

Dip Transfer Process Variables

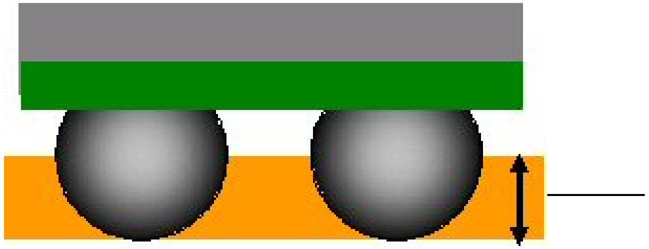
Dip Thickness

1. Immersion Depth
   - How deep should the ball go into the medium
2. Immersion Time
   - How quickly can wetting of the ball occur
3. Exit Velocity
   - How quickly can the device pull out from the medium whilst maintaining acceptable transfer consistency



Dip Transfer Process Variables

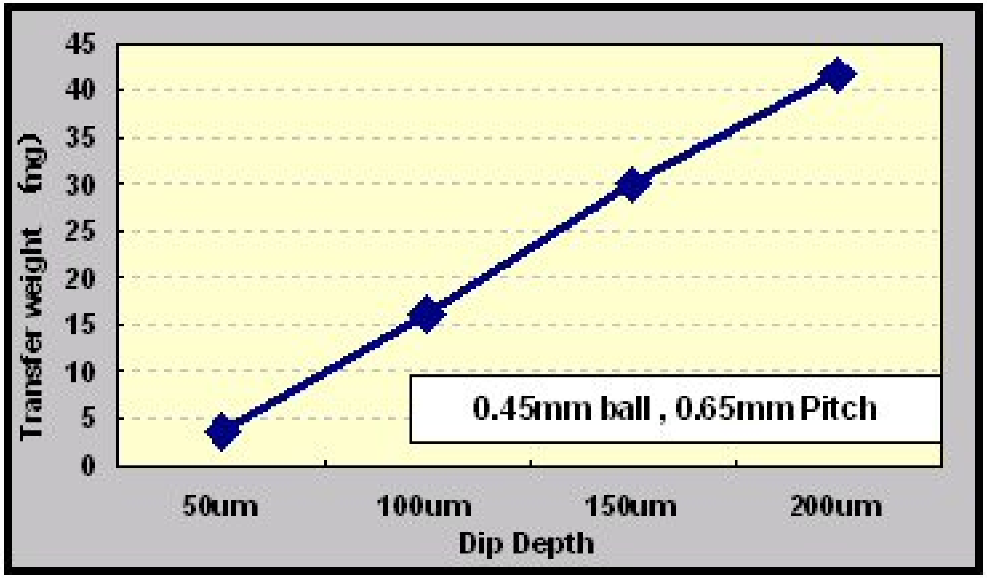
1. Immersion Depth



- Flux/Paste deposit thickness determines immersion depth in dipping unit
  - Deposition uniformity is therefore critical
- It is important to ensure that (i) enough medium is transferred but (ii) there is no medium transferred to the package body.

Dip Transfer Process Variables

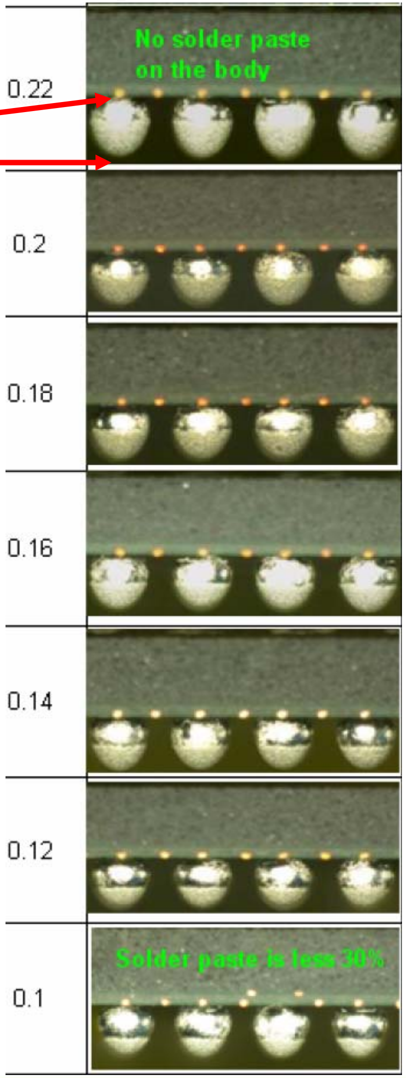
1. Immersion Depth



- This trial with a PoP solder paste showed that at a dip depth of 25% ball height, had only 35% of the transfer weight compared to a 50% ball height dip depth

Immersion Depth as a % of Ball Height

0.34mm Offset Height



65% Immersion Depth

59%

53%

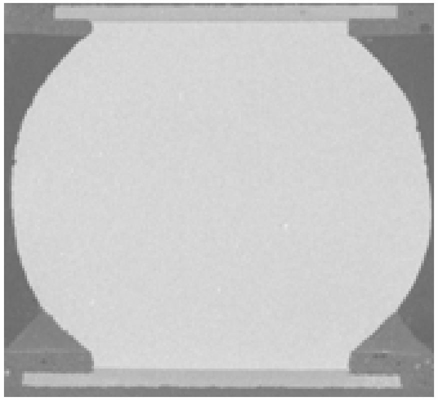
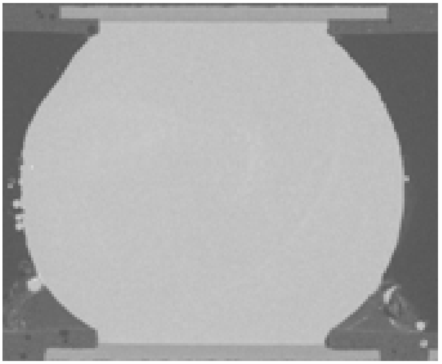
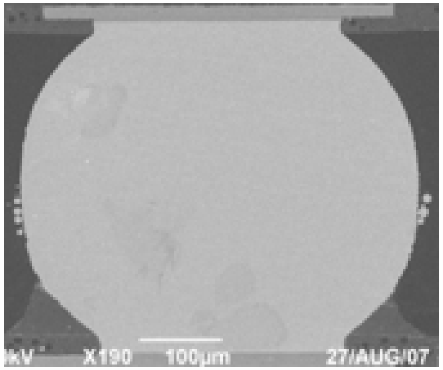
47%

41%

35%

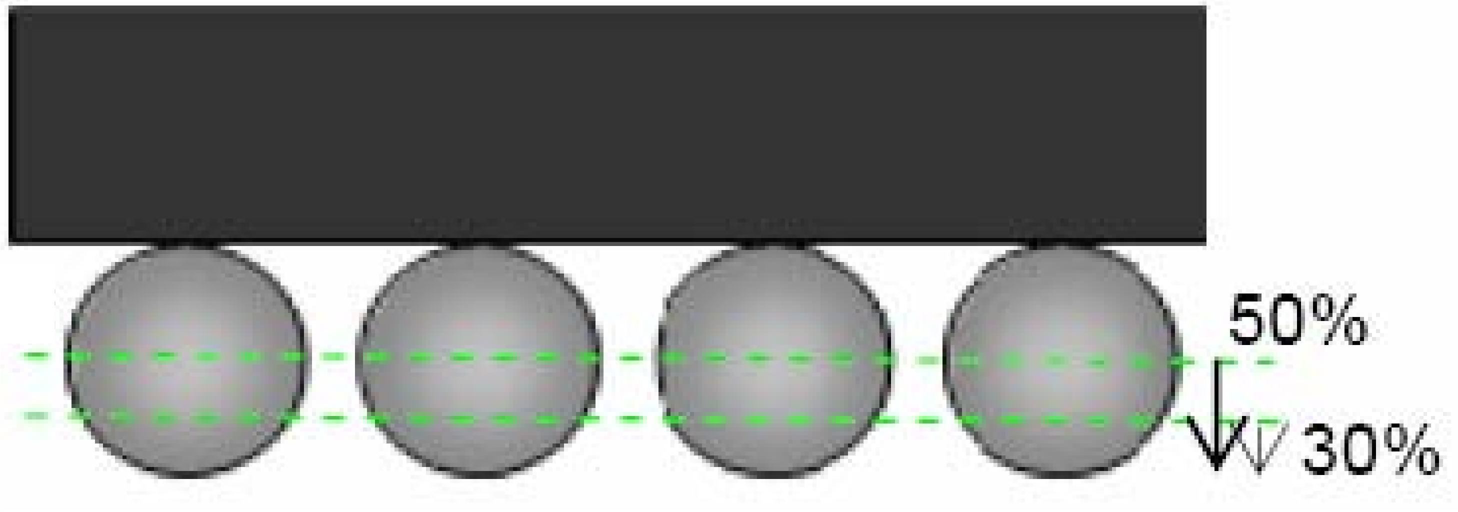
29%

Effect of Excess Dip Depth

180um	200um	220um
		
🟩 Solder ball is plump	🟥 Much solder ball happen on the solder ball edge	🟥 Much solder ball happen on the solder ball edge

- This trial with a PoP solder paste showed that >60% ball coverage may lead to excessive solder balls

Recommended Immersion Depth

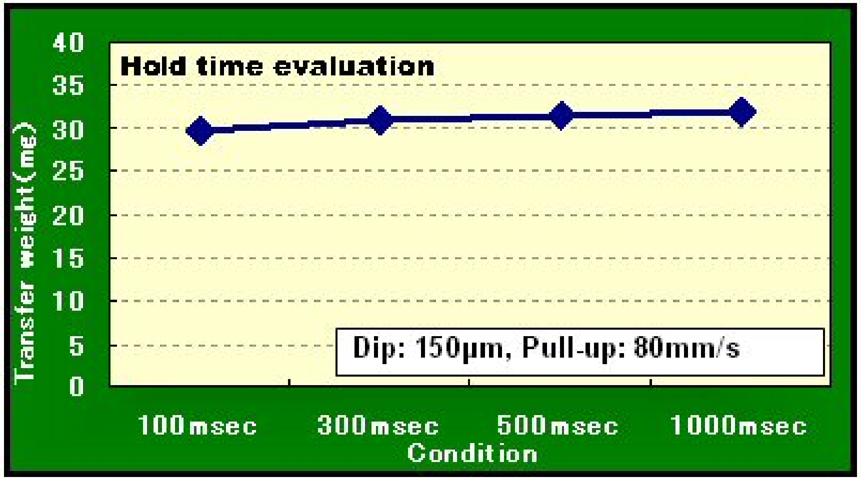


30-50% recommended by major equipment manufacturer as well

Dip Transfer Process Variables

2. Immersion Time

- Hold time needs to be long enough to enable the material to wet the ball surface, which aids transfer weight consistency

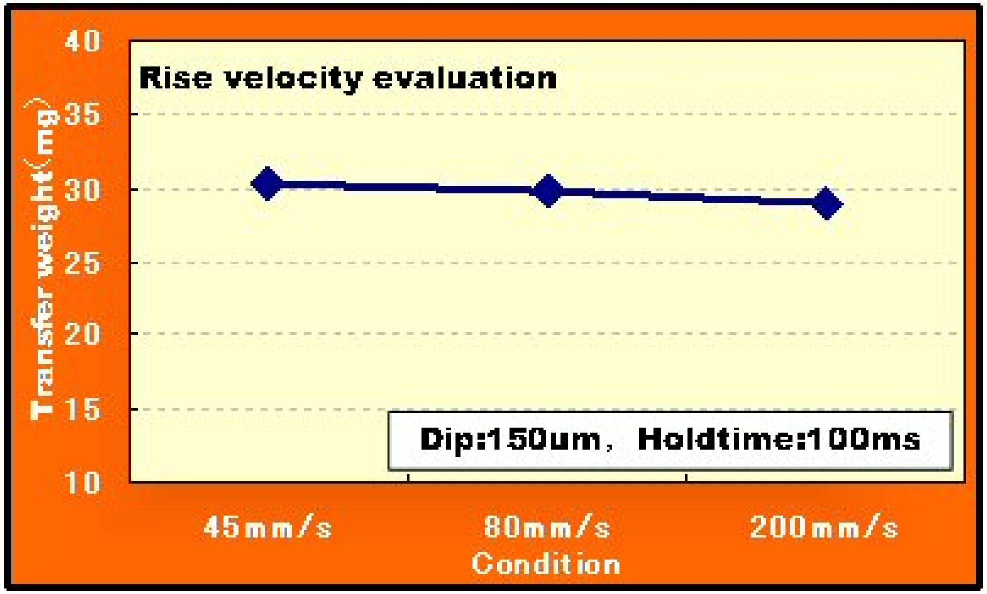


In this study it was shown that 100 milliseconds was sufficient. Longer times had no significant effect.

Dip Transfer Process Variables

3. Exit Velocity

- This is dependant on the material type
  - Modern flux/paste systems are more suited to fast shear rates



In this study it was shown that velocity had no significant effect

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PoP Paste or Flux?

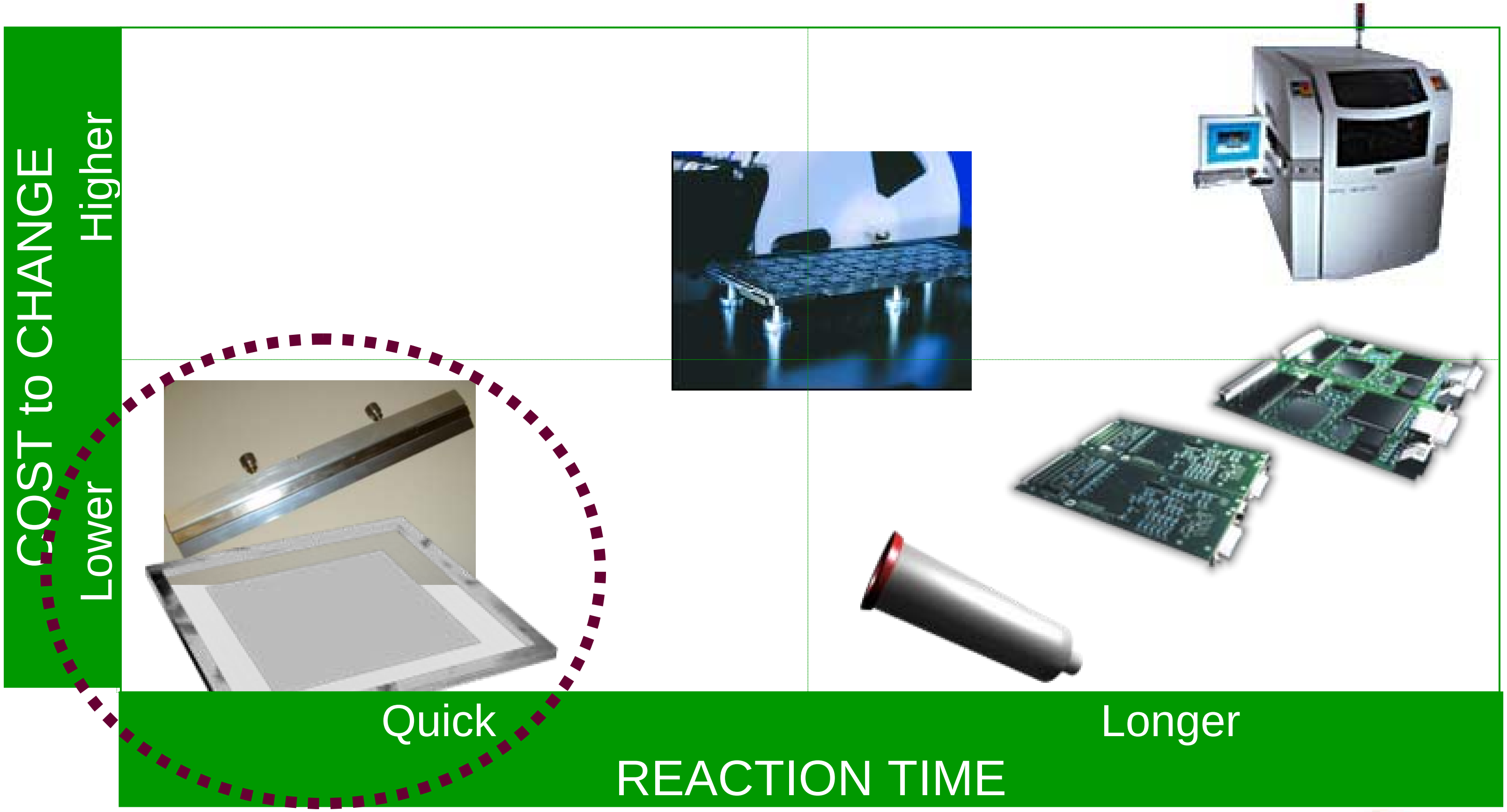
- Paste compensates for pre-reflow warp
- Paste is easier to inspect for absence/presence after the dip process
- Reflowed paste has less residue

- Flux eliminates the risk of current leakage from poor powder coalescence (solder balls)
- Flux is less sensitive to reflow profile
- Flux is less sensitive to shelf life

Process Stability

- Know Your Baseline – Acoms Razor
  - How do you know only one thing has changed?
  - Track Global Variables
- Meaningful Material Specifications
  - Tolerance Specifications – Review them periodically to make sure they make sense and hold vendor to them
  - Design Guidelines – Keep Revs
  - Capable Inspection Method
- In Line, Real Time, 3D AOI

Process Flexibility



COST to CHANGE

Higher

Lower

Quick

Longer

REACTION TIME

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