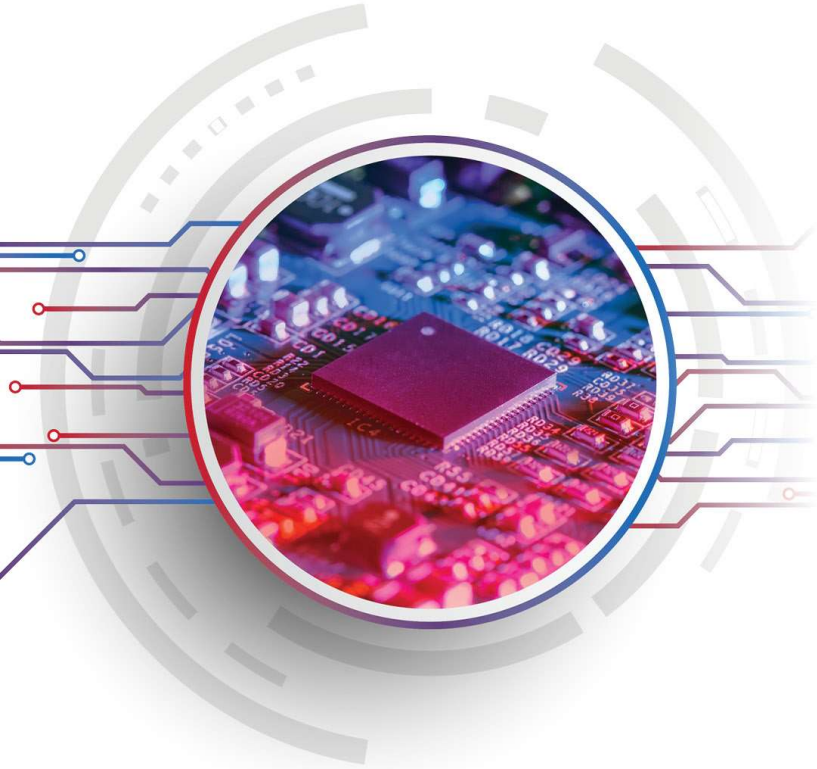


PASTE PRINTING

Module 4

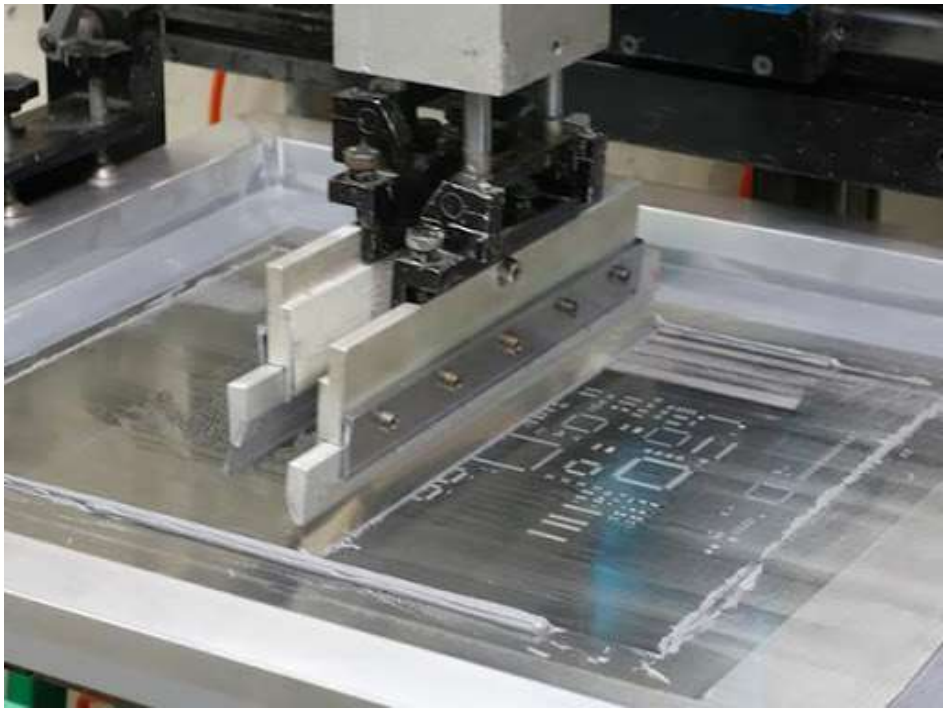
Jan 2023

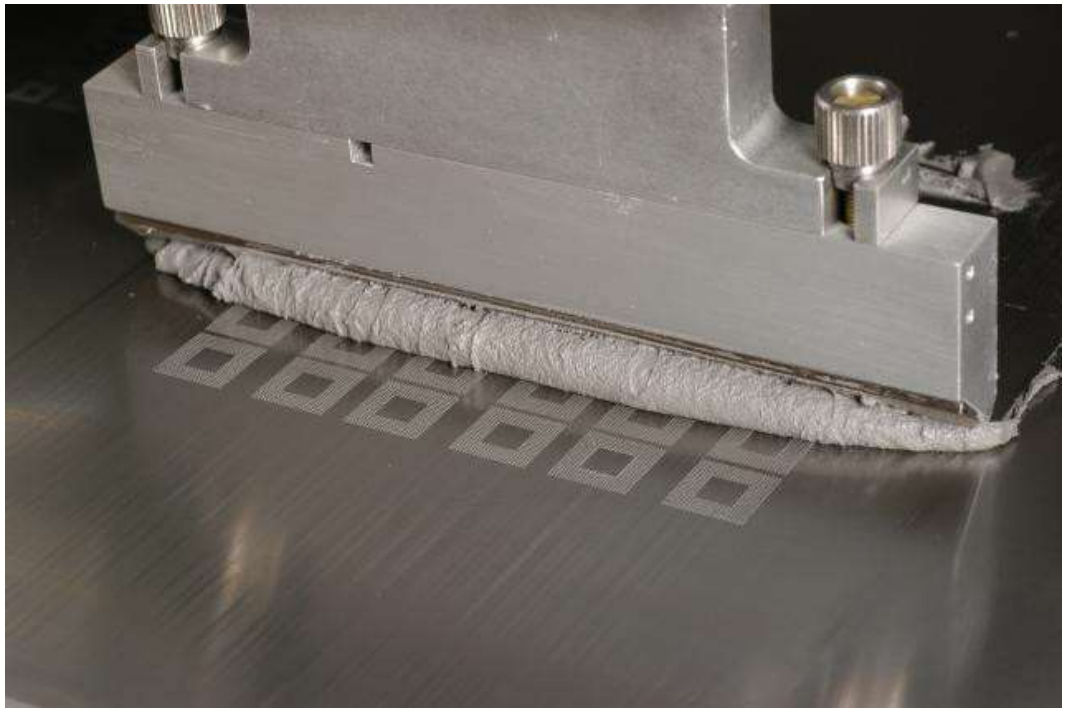
MacDermid Alpha ELECTRONICS SOLUTIONS

Paste Printing

MacDermid Alpha
ELECTRONICS SOLUTIONS

Solder Paste Printing





Most Common Paste Printing Equipment

Semi-Automatic / Off-Line Printer

Automatic / In-Line Printer

https://youtu.be/H4R6wyB95u4

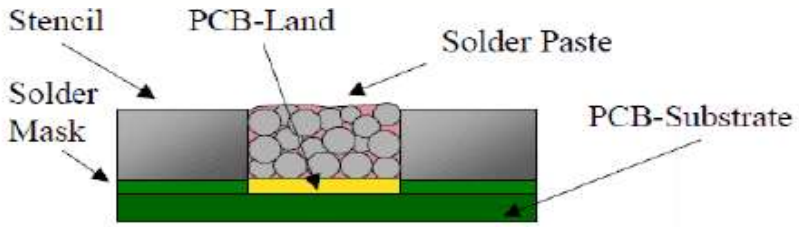
Major Auto Printing System Brands

ASM

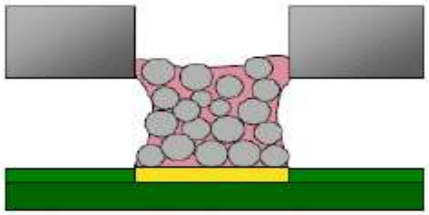
JUKI

MPM

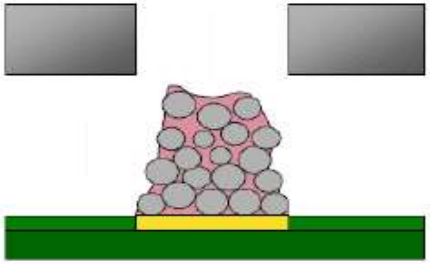
What is Paste Printing



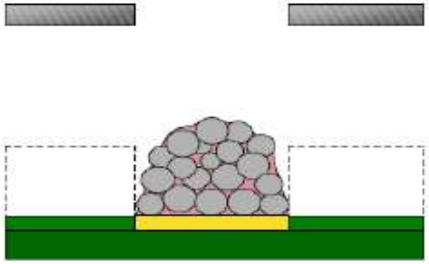
1. Aperture Filling



2. Stencil Separation

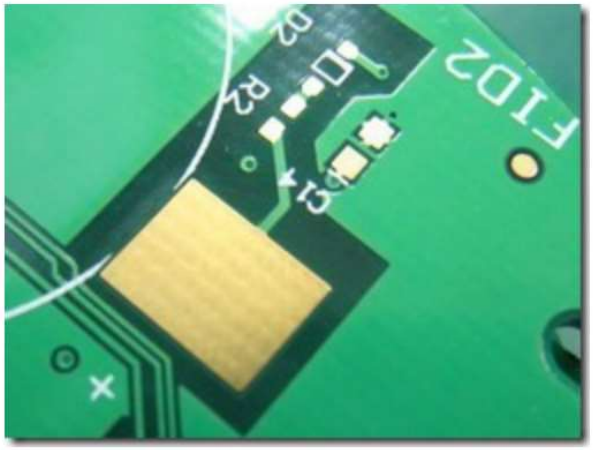
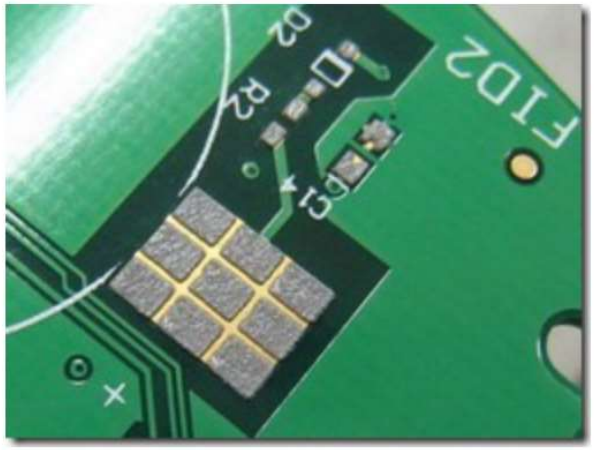


3. Paste Release



4. Solder Deposit

Solder Paste Printing

	
Before solder paste screen printing. This ENIG board only has gold on the pad surface	After solder paste screen printing. The solder paste had been printed on the big ground pad

The Solder Paste Printing Process

- Solder paste printing is one of the most critical processes in electronic manufacturing.

- The purpose of the process is to apply
  - the correct amount of paste,
  - at the correct position,
  - with the correct form and
  - being able to do this every time a print is performed.

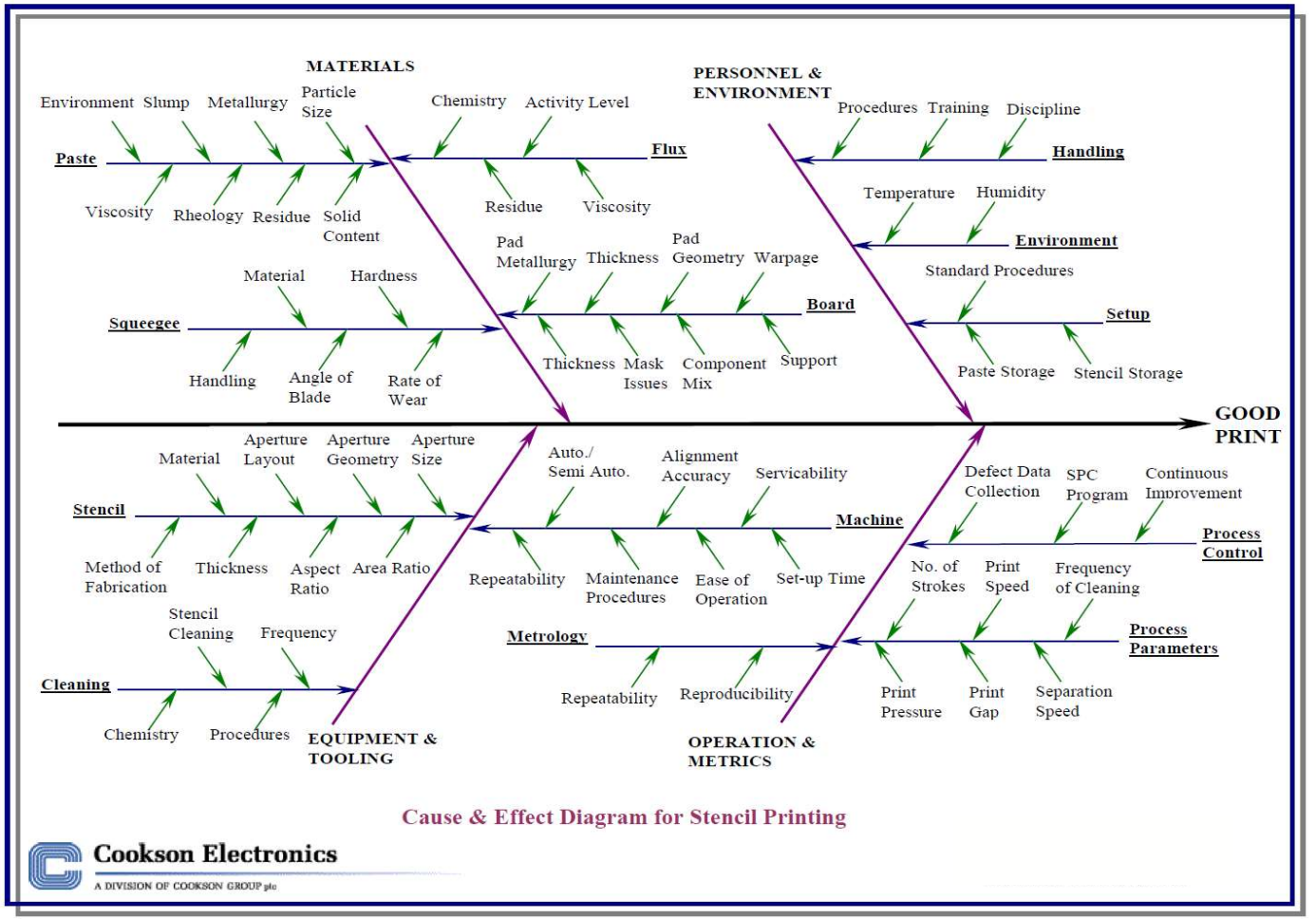
- The quality results of the print, together with the PCB provide the foundation for the rest of the surface mount process.

- A good print result is a prerequisite for a good soldering result

- A poor print will lead to additional process issues as the product travels through the manufacturing chain

How to get a GOOD PRINT?

One of the reasons that the printing process is so sensitive is because it involves mechanical tolerances, software settings, chemical properties and operator knowledge.



Market Dynamics & Trends

Electronics products and effect on PCB assembly

Decreasing cost for electronics	• Cost per placement • Higher speed lines • Higher utilization, quality & yield (DPMO, reject rates, etc.)
Build to order	• Higher mix and shorter batches • NPI turn around time • Logistics and material handling
Functionality increases and miniaturization	• More complex boards → 'broad band' PCBs • Semicon assembly – new packaging needs • Higher accuracy
Increasing safety and reliability requirements	• Higher quality & yield (DPMO, reject rates, etc.) • Higher accuracy

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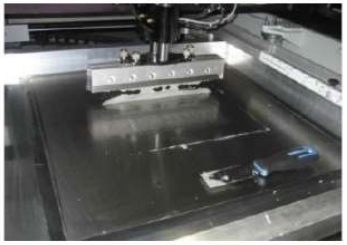
Strong Technology Trends

Technology drivers

- miniaturization
- mixing large and small components
- higher density boards
- 3D electronics and boards
- new semiconductor packaging
- new LED technology
- hybrid packaging/devices
- flexible boards

Stencil printers



- difficult to do everything on the board

Dispensers

- very slow, not cost effective
- accuracy is challenging

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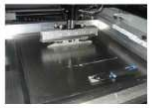
Opportunity for Jet Printing

replacing both stencil printers and dispensers

Examples

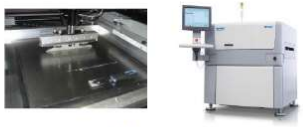
1. high-end electronics
   low to mid volume



Stencil printer

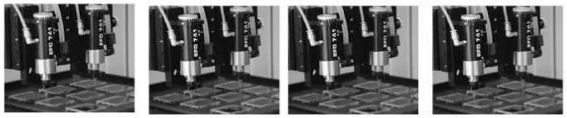
2. high volume SMT
   smart phone board

Stencil printer *Dispensing* *Dispensing*



Stencil printer

3. semiconductor
   LED technology



Dispensing *Dispensing* *Dispensing* *Dispensing*

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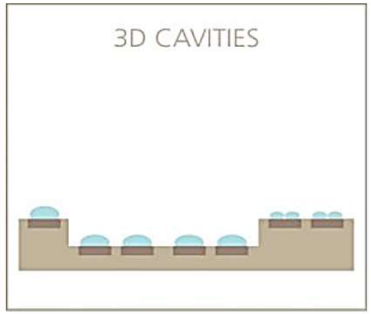
Challenging Designs

Where Traditional screen printers struggle, Jet Printing makes it possible

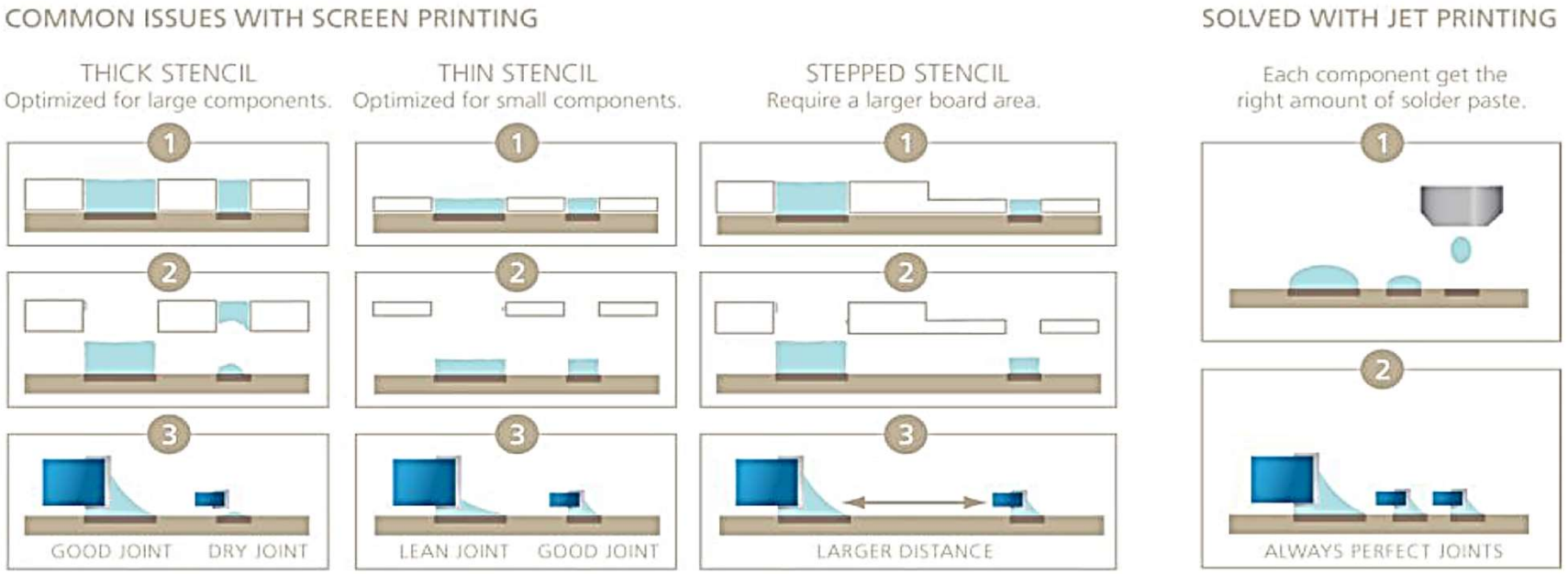
- Jet Printings is suited to the most complex of PCBA's
- Possible reflow the most challenging of components
- Traditional screen printers struggle.
- Jets millions of perfectly shaped solder dots onto each pad

With jet printing, you can easily handle multi-level PCB's

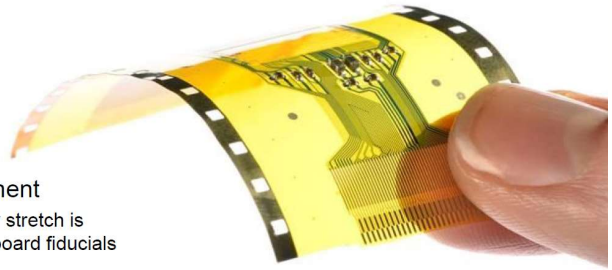


**To create the perfect solder deposit, time and time again,
a dot of paste – for every pad on the PCB.**

Which Stencil to Use



Flexible & Thin Boards - Panels

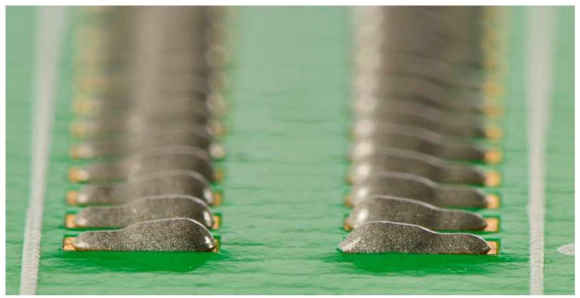


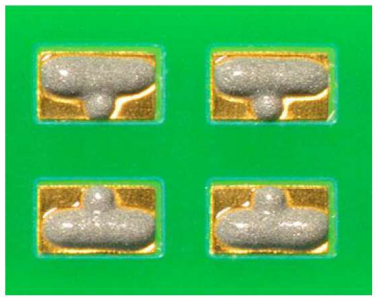
Board stretch and alignment

- Boards are aligned and any stretch is compensated for by using board fiducials

Board warpage

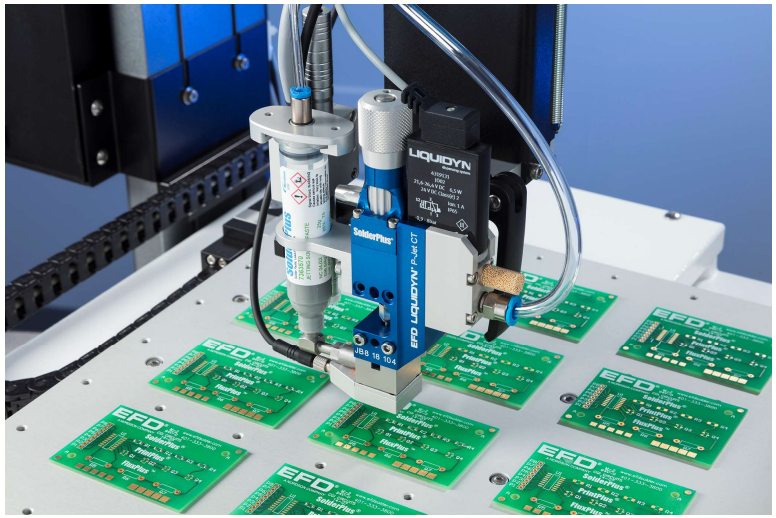
- Laser height sensor maps board surface
- Control software ensures the the print head travels with constant jet height over the board

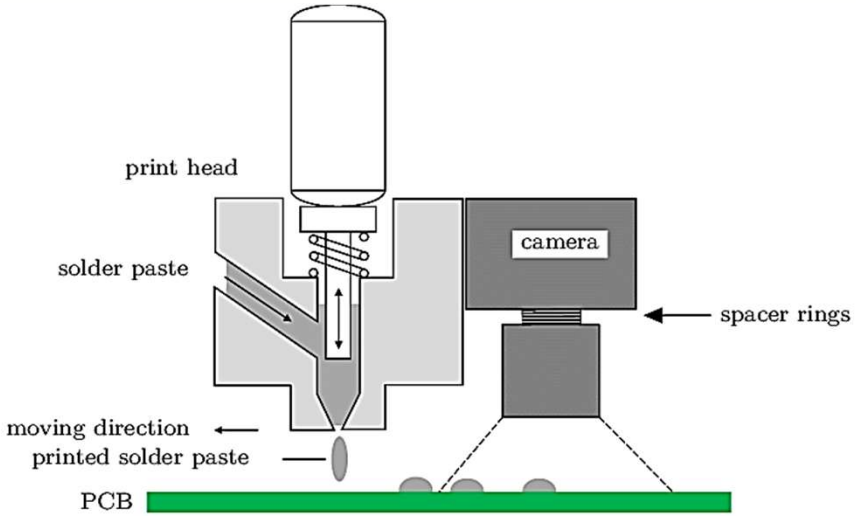




Each solder joint can be optimized for: solder paste volume, position, height, shape, pad coverage

Jet Printing





Courtesy: Nordson

Paste Print Quality Check

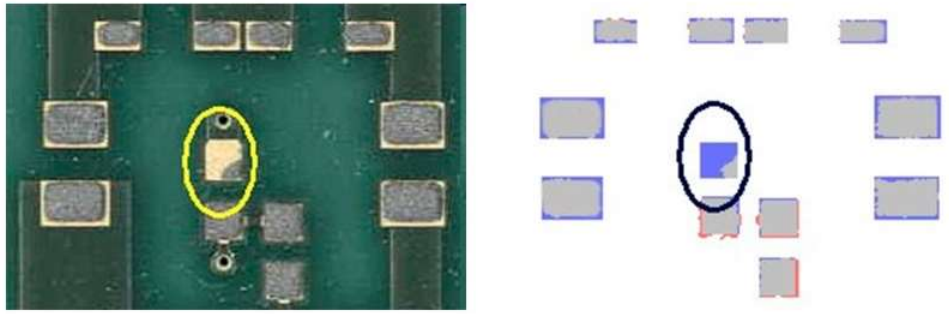
2D/3D Iinspection

Automatic inspection can be used to accurately check solder paste deposits.

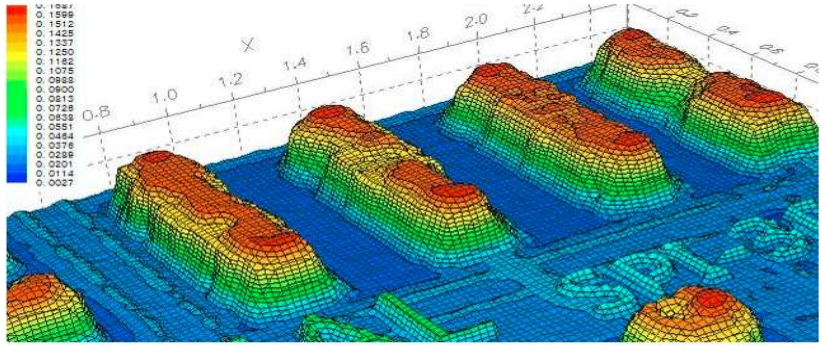
There are two types of solder paste inspection available

They are 2D inspection which checks the area of the paste deposit and

3D inspection which checks the volume of the paste deposit

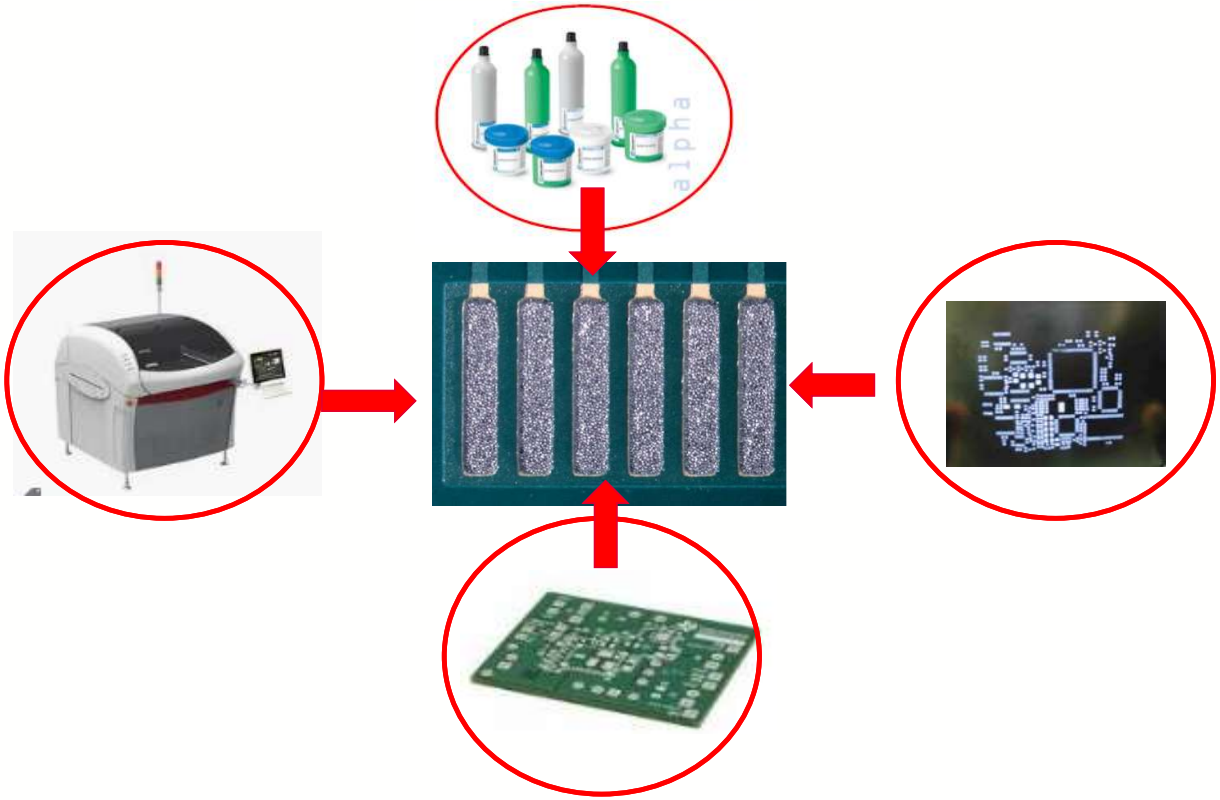


Example of fault found by 2D inspection



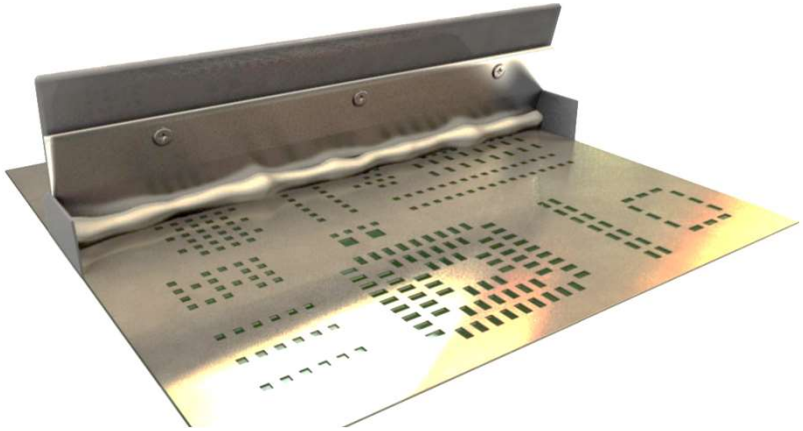
Example of 3D inspection results

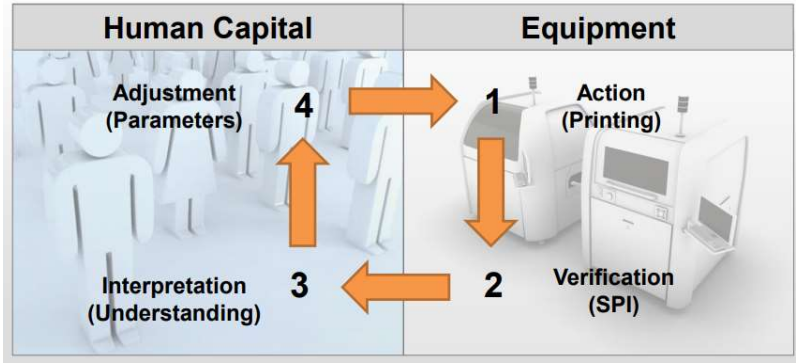
Components of Printing



Most Influencing Factors for a Good Print

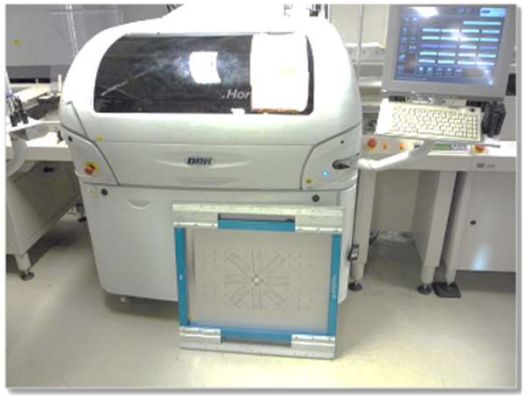
1. The Speed of the Squeegee
2. The Pressure Applied by the Squeegee
3. The Angle of the Squeegee
4. Printed Circuit Board Bottom Support / Snap-off
5. The Speed of Stencil Separation
6. Stencil Cleanliness
7. The Overall Condition of the Stencil and Squeegee
8. Squeegee Return Stroke
9. The Type of Solder Paste &
10. Temperature & Humidity



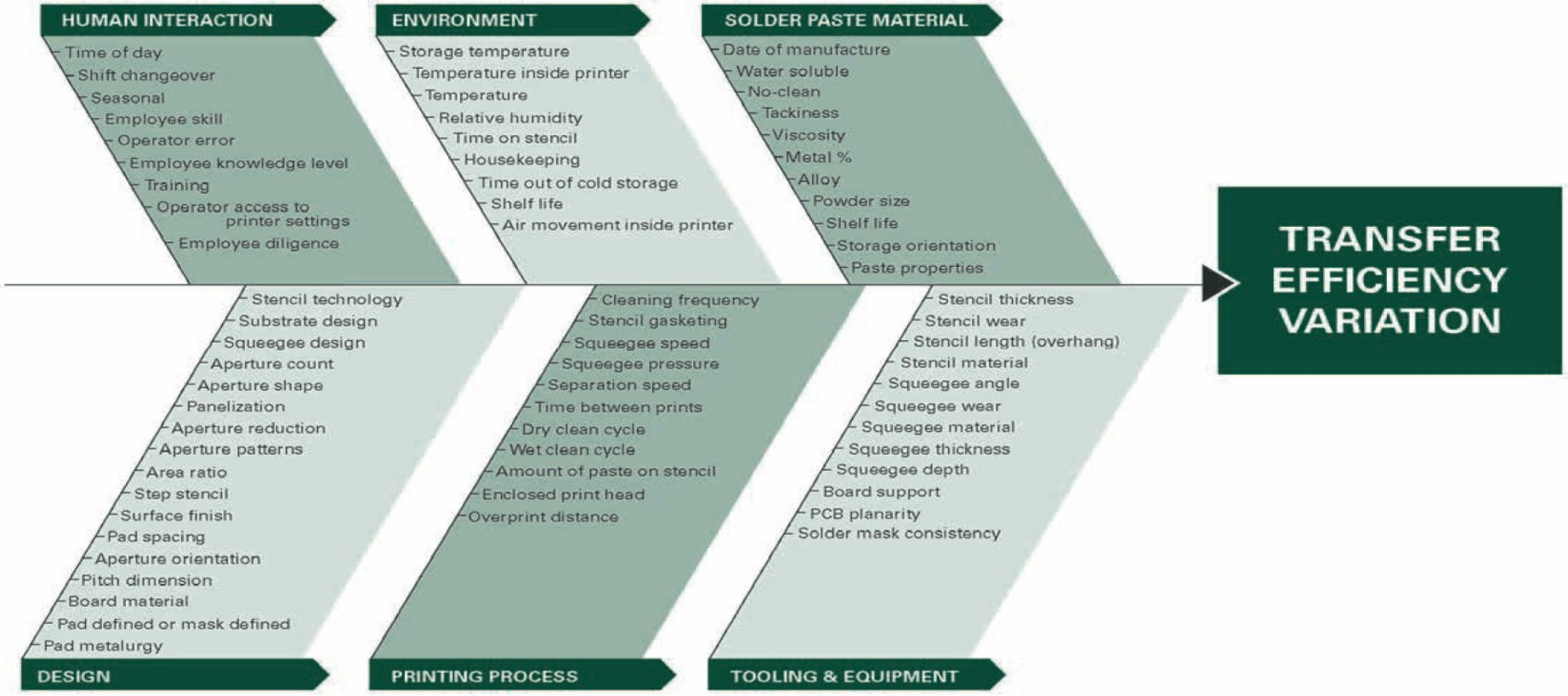


Optimisation of Process

- Process Parameters
  - Separation speed
  - Print speed
  - Squeegee pressure
  - Enclosed print-head pressure
- Evaluation of New Material
  - Solder paste, stencils, board support, wiping paper, etc.
- Verification
  - Machine status
  - Consumables
- Maintenance
  - Demand-based maintenance
  - Verification
- Environmental Parameters
  - Temperature
  - Humidity



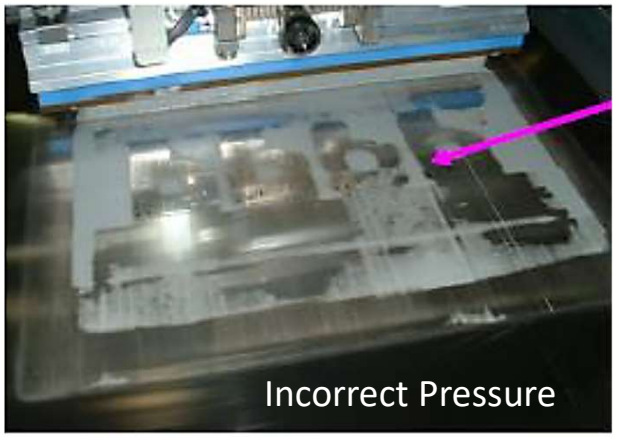
Transfer Efficiency



KIC Thermal

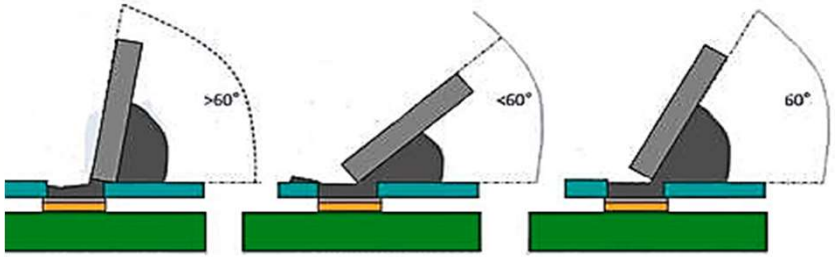
Squeegee Pressure

- It is important to apply sufficient pressure across the entire length of the squeegee blade
- A clean wipe of the stencil is an indicator for the optimum pressure.
- Too little pressure can cause “smearing”, poor deposition, and the incomplete transfer to the PCB.
- Too much pressure can cause “scooping” of the paste from larger apertures
- This can cause excess wear & tear on the stencil and squeegees,
- Will end up causing “bleeding” of the paste between the stencil and PCB.
- A typical setting for the squeegee pressure is 500 grams of pressure per 50mm of squeegee blade.



Process Parameter -Squeegee Angle

- Generally, the squeegee blade should be angled at 60° to the stencil surface.
- Sufficient downwards force should be exerted as the squeegee blade traverses the stencil, on the printing stroke, to ensure the paste rolls and fills the finest stencil apertures.
- Decreasing the blade angle to 45° will provide extra downwards force to encourage increased aperture filling.
- Care should be taken to ensure the squeegee blade pressure is not excessive at this angle as it is possible to break the gasket seal between the stencil and the PCB resulting in bleeding, bridging and shorts.



Effect of squeegee angle

PCB Support

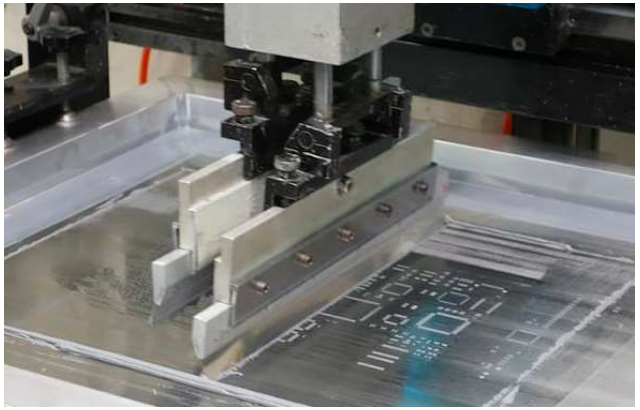
- This is an important factor to ensure the PCB is held flat against the stencil during the printing process.
- If the PCB is not fully supported it can lead to printing defects such as a poor paste deposit.
- PCB supports come with printing machines which are a fixed height and have programmable positions
- There are also adaptable PCB support available of varying designs like moulds
- They mould themselves to the PCB and are useful for double sided assemblies.

Example of adaptable PCB support in use

Squeegee Blades

- Two types of squeegee blade materials are used in the stencil printing process:
- Metal blades and polyurethane blades.

Polyurethane



Metal / SS Squeegee

Polyurethane Blades

- Polyurethane blades with a high durometer rating (90-110) have shown success in many applications,
- When using rubber squeegees, 70 to 90 durometer hardness squeegees are used.

  Excessive pressure causes paste bleeding underneath the stencil may lead to bridging and will require frequent underside wiping.
- Requires frequent sharpening as the wear and tear is high

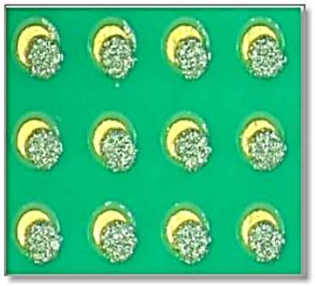
Metal Blades

- Metal squeegees blades are most commonly used and operate at lower pressure than rubber variants.
- They do not scoop paste from apertures, as they are metallic, they do not wear & tear as easily as rubber types
- They do not need to be sharpened.
- The popularity of metal squeegees has grown with the prevalence of finer pitch components.
- Metal squeegee blades are typically made from stainless steel in either a single thickness (0.150mm) config
- Can be manufactured with an etched recessed edge where the base material is 0.300mm thick and the edge is tapered down to 0.150mm.
- But for those applications with denser boards and smaller components, metal blades are more reliable.
- This is primarily because metal squeegee blades *allow a more controlled and consistent print height across the entire board area compared to poly blades.*

Alignment

Is it the stencil or the PCB?

- Electroformed stencils exhibit more size and positional problems than laser cut, so if the stencil is electroformed the alignment issue is more likely to lie within the stencil than if it were laser cut.

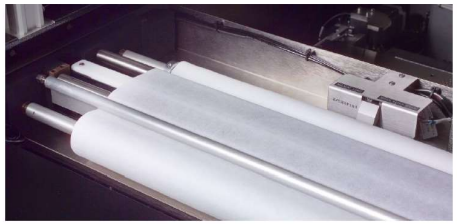


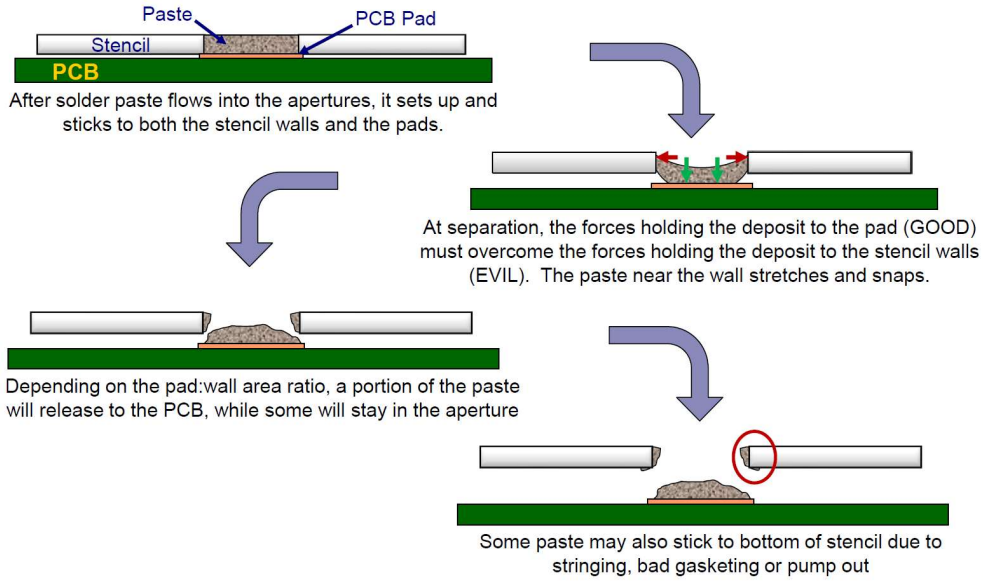
- Laser cut stencils are only as accurate as their cutters. Well calibrated cutters make precise stencils; sloppy cutters make sloppy stencils.
  - Generally, misalignment problems with *good quality* laser cut stencils are related to the PCB.

Courtesy: Chrys Shea

Under-Stencil Wiping

- Criticality increasing due to
  - Component miniaturization
  - Density / Placement of components
  - Need for improved yields
- Wipe options
  - Dry/vacuum
  - Solvent
    - IPA
    - Specially engineered materials
- Historically, not a lot of science was applied to the process





Courtesy: Chrys Shea

PCB Pallets

PCB Pallets / Carrier

- Transport pallets allow for simultaneous assembly on multiple PCB's maximizing though-puts
- It is a necessity with odd geometry PCB's or with boards that are difficult to transport in edge conveyors.
- Surface Mount Process Carriers are engineered to precisely align and hold circuit boards from start to finish
- These carriers are made of high-temperature semi-conductive composite materials, like imported synthetic stone, magnesium alloy, FR4, and are used from start to finish in the assembly process.

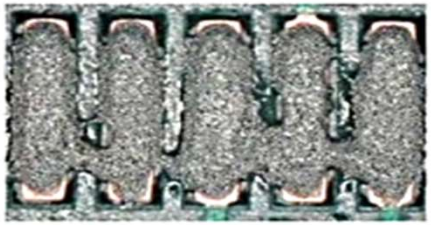
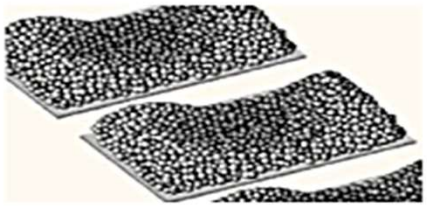
Benefits

- Reduces setup time
- Eliminates unnecessary PCB board handling by operators
- Minimizes board warping
- Eliminates expensive hand masking and labour costs
- Standardizes process repetition
- Machine parameters
- Minimizes soldering defects

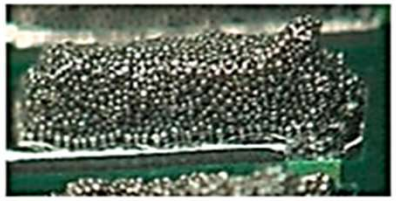
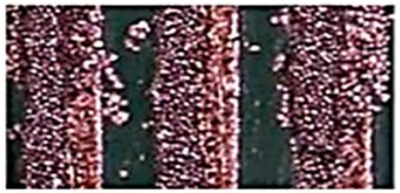
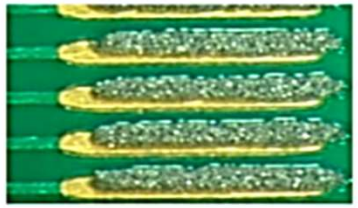
Max Board Size

Printer Make	Min		Max	
	Length	Width	Length	Width
DEK -Horizon	40mm	50mm	510mm	508mm
Juki - PMA-XII	100mm	65mm	1220mm	800mm
MPM	50.8mm	50.8mm	609.6mm	508mm

Common Printing Defects

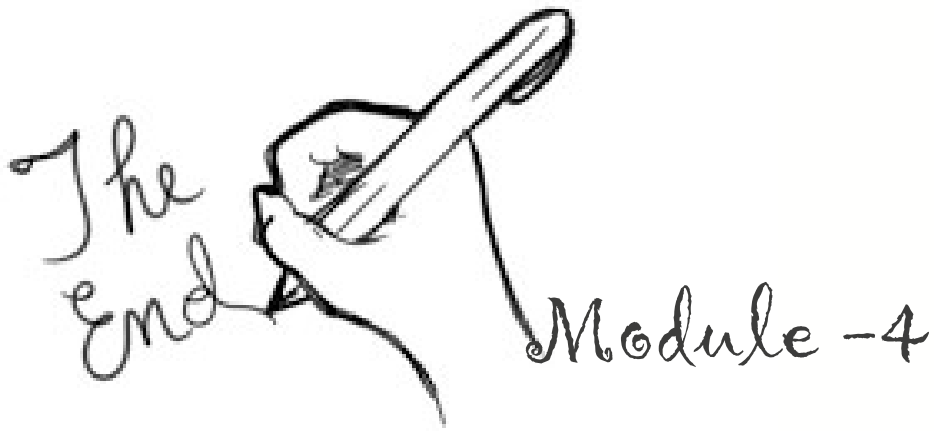
Defect		Cause	Action
Slump		Printing process operating in environmental conditions outside recommended range	Installation temperature control module to regulate temperature and humidity within printer.
Scooping		Squeegee pressure too high, stencil damaged or oversized aperatures	Optimize squeegee pressure, redesign stencil aperatures to reduce size
Bridging		Stencil tension low, PCB support insufficient, poor cleanliness, poor paste quality	Correct stencil tension, cleanliness, improve PCB support and verify paste quality

Common Printing Defects

Defect		Cause	Action
Peaking		Stencil process speed too high, stencil condition/cleanliness or aperature damage	Modify PCB separation speed, check stencil
Bleeding		Poor gasket between PCB and stencil, PCB support, squeegee pressure high, poor stencil or cleanliness	Ensure stencil aperture size is smaller than pads on PCB, improve PCB support, reduce squeegee pressure, check stencil for damage.
Mis-alignment		Printer alignment error, PCB shrink or stretch, insufficient PCB support.	Verify PCB to stencil alignment, fiducial marks are flat and well positioned

Summary

- The printing stage of the assembly process is vitally important.
- If there are errors introduced at this stage there will be “knock on” effects throughout the process ultimately resulting in process failures.
- To achieve good repeatable printing results, it is important to use a stencil that is designed with all the appropriate points considered.
- Accuracy & Repeatability of volume of paste sets a base for high FPY



ANY QUESTIONS?