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Bridge Detection in the Solder Paste Print Process

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Abstract
This paper describes part of a research effort currently under way in the field of print defect detection. The techniques described have proven to be robust and particularly well suited for detecting troublesome bridge and bridge-like features that span the gap between pads.

Introduction

The solder paste print operation is widely recognized as a common source of defects in surface mount assembly. One approach to increasing the yields associated with the solder paste deposition process is to detect print defects immediately after the print operation and reject defective boards before placement of electronic components. This enables SMT manufacturers to save time otherwise wasted in the assembly of defective boards and avoids costly rework.

The next logical step includes trend analysis for adaptive process control and, ultimately, prevention of defects. Whether or not a defect is reported at any specific site, SPC data can be collected, monitored, and used to correct undesirable trends before they become critical to the assembly process.

Inspection Sequence

Our general approach to inspecting printed circuit boards is illustrated in Figure 1. The acquired image is processed so areas of the board that are covered with paste are more easily identified. Once appropriate regions of interest are defined, various techniques are used to either quantify paste coverage on or in the vicinity of pads, the gap between pads, or to characterize bridge-like features. A similar process can be used to inspect the stencil for paste-in-aperture and paste-on-foil between apertures. The resulting measurements are compared to user defined process limits, and historical data is used to monitor trends for effective control of print functions.

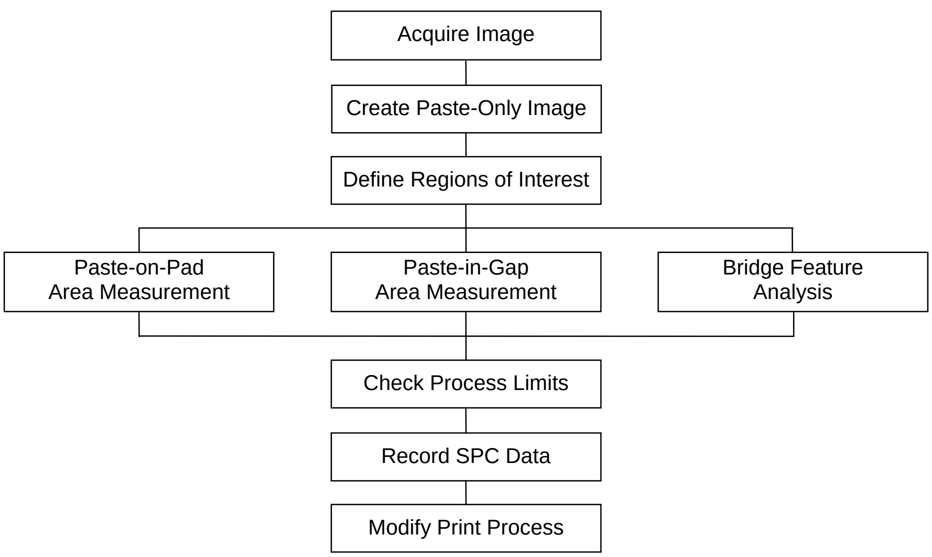

Figure 1 - Inspection Sequence

Defect Prevention – by Design

An effective first step in print defect prevention is to ensure that only properly designed, manufactured, and maintained boards, stencils, and paste are used in the process. The ability to automatically compensate for marginal or defective materials, or a fundamentally flawed design, is limited. Machines that are able to successfully adapt may do so with increased cycle times.

Stencil apertures should be designed to consistently transfer the volume of paste required to make reliable solder joints. Design considerations include inherent characteristics of the paste, foil thickness, aperture finish, aspect ratio, pad geometry, pad finish, board and stencil stretch, and gasket tolerances.

Well-targeted statistical sampling is sufficient for spotting trends for effective SPC when the process has at least some degree of natural stability and remains within a reasonable range of control. Poorly suited boards and stencils may require 100% inspection to detect an increased number of random defects. Prevention of defects is more difficult since SPC data may be unreliable under these conditions.

Full (100%) post-print inspection may require addition of a separate and dedicated station to maintain adequate throughput. With this in mind, it may be more practical, and cost effective, to adjust stencil and board designs to achieve more "normal" performance within an acceptable and predictable range of control. Once within this range, targeted statistical sampling can be used to dynamically tune the process while still checking critical areas 100%, as required, for defects.

Paste Detection – an Enabling Image Process

The term Paste Detection can describe any image processing technique that separates solder paste from non-paste features to create a new "paste-only" image. This paste-only image is analyzed in a later process to determine the quantity, location, or significance of paste deposits.

Paste detection methods include direct application of single or multiple thresholds to the captured image, image subtraction techniques, and texture based segmentation. Variations may include use of UV-dye enhanced paste, laser profiling or other means that provide a topographical (3D) image that can be similarly weighted, and x-ray techniques. In fact, any method that appropriately isolates paste from non-paste regions can be used for subsequent analyses … like bridge detection. Examples of texture-based paste detection are shown in Figures 2 and 3. Figure 3 includes an interesting 3D plot of 2D texture-based probability data, where higher elevations indicate a higher probability that paste is present at this location.

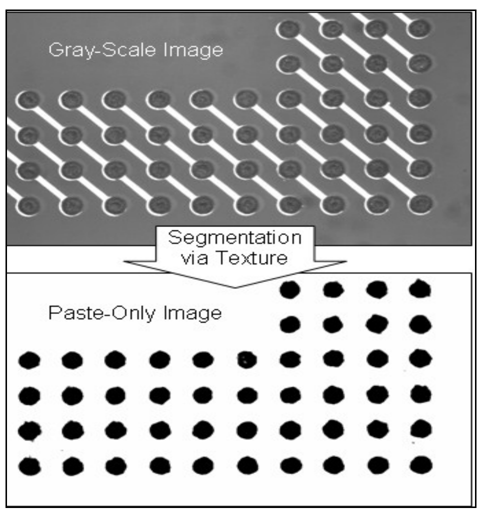

Figure 2 - Gray-Scale and Paste-Only Images

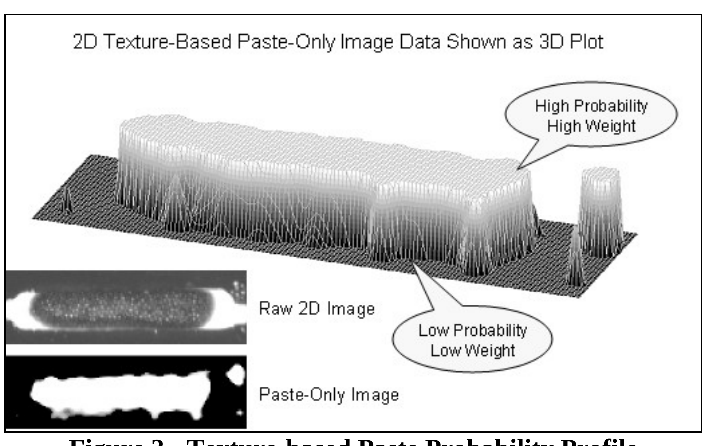

Figure 3 - Texture-based Paste Probability Profile

Bridges and Other Print Defects

In solder paste printing operations, the term "bridge" generally describes a print defect where some amount of stray paste spans the gap between adjacent pads. At critical dimensions, a paste bridge may fail to pull back during subsequent re-flow operations causing a short or other related defect in the final assembly. Not all bridges or bridge-like defects have the necessary mass or geometry to adversely affect a given process. Conversely, gap defects that actually are significant to a process may not always connect adjacent pads to form a well-defined bridge.

Bridges are not the only type of print defect. Excess paste, poor print definition, and poor alignment also increase the probability that similar defects, notably "shorts", may appear at this location later in the assembly process. Although subsequent processes certainly play a part in determining the quality of the final PCB assembly, detection and accurate assessment of bridge and other defects, as printed, would provide the most direct feedback for process control of appropriate print functions.

Assessment of bridges, bridge-like features, and other print defects can be a subjective task with few hard rules or limits. Yet a machine can only analyze tangible characteristics. Reliable methods to classify and weigh the significance of print defects as they relate to the process are required to provide meaningful output and to define realistic and useful process limits. Bridge, bridge-like, too much paste … these are subjective descriptions of print defects. Without further technical assessment, none of these can predict with certainty that a bridge-related defect will appear later in the process. In fact, no form of measurement can predict this with certainty. They may, individually or together, indicate a process trend where the probability of such a defect is increased.

Print Defect Characterization

Bridges or bridge-like features are said to occur when a relatively well-defined deposit of paste spans the gap between pads, or nearly so, or beyond predefined limits. Various bridge-like characteristics must be measured to determine the probability that a specific feature will cause a related defect later in the assembly process. The same data can be used to monitor lesser trends for effective control of the print process.

As the span or "reach" of a paste feature increases across the gap, so does the significance of the feature. A classic bridge would span the entire gap, but span alone does not guarantee that a related defect will occur later in the process. Something less than full span could be equally troublesome, or equally benign. Additional characteristics must be considered to gauge the true significance of a defect to the process.

Although sections along a bridge may be narrow or "weak", or its bridge-like geometry poor, the probability that bridging will occur at some point during re-flow may be great due only to the amount of paste involved. As the area covered by the paste feature increases, so does the probability that it will cause a bridge-related defect when sufficient span exists across the gap.

The thinnest point along the bridge feature … its weakest link … may indicate an ability or tendency to pull back during subsequent re-flow. If a section along the bridge is sufficiently narrow, the probability that the paste will break and pull back from this point is greater than a deposit that remains relatively (or critically) wide at its narrowest point. As the width of the paste feature increases so does the probability that it will cause a bridge-related defect, provided a sufficient span exists across the gap and the total amount of paste forming the bridge is sufficient to maintain it at re-flow.

Detection of Significant Paste-In-Gap Area and Bridge-Like Geometry

We have developed a unique gap defect analysis that provides reliable paste-in-gap area measurement and detects significant geometry and span of bridge-like paste features as they relate to the SMT assembly process.

The total amount of paste in a gap and the effective span of bridge-like features across the gap are used together to determine the probability that a specific paste feature will cause a bridge-related defect later in the assembly process.

A general "Paste-in-Gap" defect would occur when the total quantity of paste, regardless of shape or location in the gap, is beyond predefined limits. An actual paste bridge need not be confirmed, and no further characterization of the defect is required to qualify it as such. This condition indicates poor print quality, poor alignment, bridging, or all of these, with increased probability that bridge-related defects, primarily shorts, will appear at this location later in the assembly process.

A more specific "Bridge" defect would occur when the span of a bridge or bridge-like feature is beyond predefined limits.

Simple User-Defined Bridge Detection Parameters

We have reduced user-defined input to the following:

1. Maximum Paste-in-Gap Area … as a percent of total gap area
2. LOW, MEDIUM, HIGH Sensitivity … of the bridge detection measurement
3. Maximum Span … of bridge-like features across a gap, as a percent of gap width

The reported span is effectively qualified by the chosen degree of "sensitivity" and is a most valuable measure of actual bridging potential. The operator selects LOW, MEDIUM, or HIGH bridge detection sensitivity to define a bridge of minimum sufficient bulk, or width, in relative terms, for the purposes of measuring the equivalent span of bridge-like features that are at least as significant. The LOW setting requires a bridge-like feature to have more critical mass, "bridging strength", or significant "bridging geometry". The HIGH setting measures the span of much finer and less substantial wisps of paste. With bridge sensitivity set HIGH and span limits set relatively low, a higher number of short and wispy bridge-like features is detected.

While the maximum "paste-in-gap" and "span" (bridge potential) are set independently, mathematically, the total paste-in-gap area can never be more than the maximum span of bridge-like features reported in the same gap. The span limit becomes a de-facto paste-in-gap limit. This enables and even more simplified, optional, user interface.

Minimum User-Defined Detection Parameters

1. LOW, MEDIUM, HIGH Sensitivity … of the bridge detection measurement
2. Maximum Span … or "Bridging Potential" … of bridge-like features and de-facto maximum working paste-in-gap area

Bridge Feature Detection – Graphic Example

Figure 4 shows graphically how the image of a bridge-like feature is processed and evaluated based on a user-defined level of sensitivity. In this example the width of the gap region-of-interest is determined by stencil aperture geometry. This is logical, since with good print definition no paste should be present in the area between apertures, by design. As an added precaution, the gap region is slightly elongated to account for any paste that may extend beyond the ends of the aperture.

The bridge-like feature shown in Figure 4 is quite thin and would be difficult to detect by eye. Although paste spans the entire width of the gap, total paste-in-gap area is very small. In fact total paste area is below 10 percent, or well below any practical limit that would avoid false detection due to perfectly acceptable process variability. This highlights the need to also detect and accurately measure effective span of significant paste geometry across the gap, in parallel, since area measurement alone obviously provides incomplete bridge detection or prevention analysis.

The solid gray line in Figure 4 is a profile of raw paste-only image data as projected along the bridging axis. Areas in the paste-only image having high probability of being paste are white, while areas of lesser probability appear as appropriately weighted shades of gray. In order for any part of the profile to reach the opposite side of the plot all "paste" pixels must have full value, in other words, they must have maximum probability of being paste. Even so, in some cases a full span might consist of a single bridge-forming thread of paste having dubious defect-causing potential. This makes direct use of raw or "unconditioned" paste-only data impractical for the purposes of automated defect detection as applied to print operations and subsequent related assembly processes.

In contrast, the black dashed line shows an equivalent profile of the same paste features taken at "medium sensitivity", a relative setting, as chosen for the purpose of assigning more weight to features with more significant bridging geometry, and less weight to lesser, wispy, bridge-like features.

The gray dashed line shows the equivalent profile and bridge potential when taken at "low sensitivity" … to effectively measure only features with the most defect potential.

The user-defined span limit, or threshold, is shown as a dashed vertical line at 70 percent. Therefore, in this example, a bridge-like feature would be reported as having significant defect potential, or not, based on the user-defined sensitivity setting. In either case data is collected for trend analysis and SPC.

Detection of larger and more significant bridge-like features is less affected by the user-defined sensitivity setting. This, conveniently, ensures even more consistent detection of these larger features.

As stated earlier, no measurement or degree of accuracy can guarantee that a "short" will or will not be present at any given location after re-flow, but the probability can be estimated using this system, and the system can be tuned to best suit the users needs.

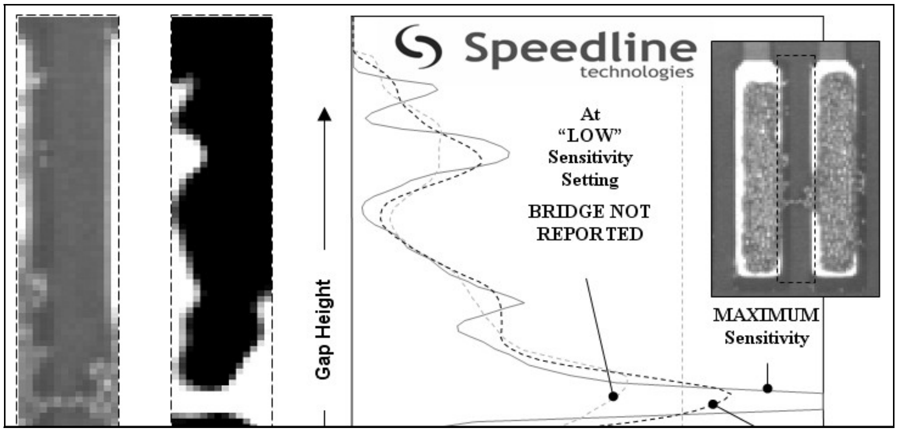

Figure 4 - How the Image of a Bridge-Like Feature is Processed and Evaluated Based on a User-Defined Level of Sensitivity

Bridge Probability – Computer Generated Example with Multiple Defects

Figure 5 is a computer-generated paste-only region of interest with two distinct defects located in the gap between pads. Each defect covers exactly 8% of the total gap area. The total paste-in-gap area, 16%, may still be within a reasonable range of process variability when all contributing factors are considered. To avoid nuisance detections, it would be best not to set paste-in-gap limits this low. Usually, as in this case, span information is a more valuable indicator of bridging potential.

The span, or reach, of each feature across the gap is also identical at 80%. Different geometries were chosen to demonstrate how shape affects bridging potential. Features are well separated to better demonstrate local bridging potential, and extend from opposite sides of the gap to demonstrate functional equivalence in determining "effective" span. Of course when paste-in-gap features are directly opposite each other, or nearly so, the combined reach effectively creates one bridge-like feature across the gap … and defect potential is estimated correctly.

Figure 6 demonstrates the affect of various sensitivity settings as applied to the gap region of Figure 5. A synthesized paste-only gap region appears at left. White is paste, black is not. Remaining gap regions were created directly from processed data and highlight differences in effective (inherent) potential of the features when taken at various sensitivity settings. The same user-defined span limit appears as a dashed vertical line in each of the derived images and the annotated plot.

In this example a bridge-like defect is reported at each of the sensitivity settings since at least one feature exceeds the user-defined span limit of 65% … in each case.

In general, similarly blunt and/or substantial features tend to maintain more effective bridging potential after processing than do finer less substantial features. User-defined sensitivity settings have a quantifying effect. Reported results tend to parallel real-world bridging potential of similarly shaped features.

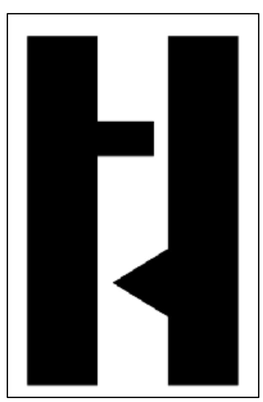

Figure 5 – Synthetic Paste-Only Image with Gap Defects

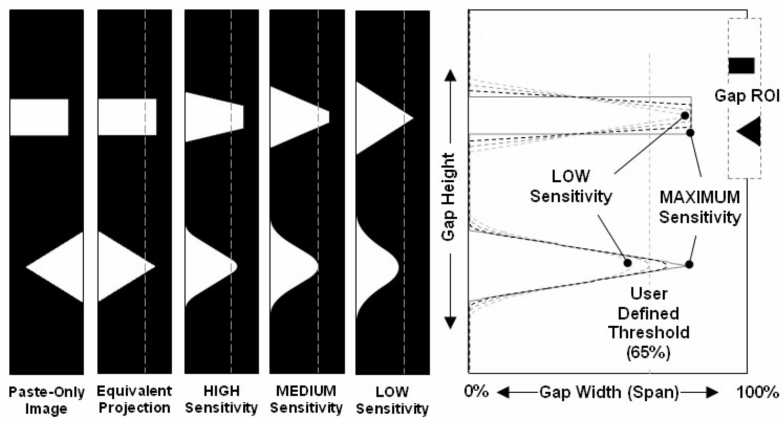

Figure 6 – Effect of Sensitivity on Computer Generated Example

SPC and Trend Analysis

Whether or not a limit is exceeded or defect reported at any specific site, the same data can be appropriately filtered and used to monitor lesser trends for effective control of the print process. The minimum, maximum, and average amount of paste found in gaps between pads can be saved after inspection of each device. The same can be saved for span measurements of bridge-like features. This not only enables trend analyses for effective process control, it provides a means to fine-tune detection parameters based on historical performance and realistic production requirements … rather than by trial, error, and subjective speculation.

Additional Means of Prevention

One source of additional preventive information is provided via stencil inspection. Stand-alone AOI machines have no access to the stencil since it is completely enclosed inside the printer during production. Since stencil inspection and paste deposition are mutually exclusive events inside the printer, excessive or unnecessary stencil inspections should be avoided to save time.

Here again, well-targeted sampling is sufficient for spotting trends and identifying probable cause of defects found on the PCB. It would be logical to include stencil sites that are more likely to produce defects. Targeting dynamics may include self-triggered inspection at stencil sites directly linked to locations on a PCB where trends or defects are most likely to occur, or have in fact just occurred. Addition of stencil inspection helps identify and initiate only the most appropriate corrective actions … in a timely manner.

Figure 7a shows a stencil contaminated with paste and resin. This condition reduces print definition and, if left unchecked can eventually lead to the kind of defect we are trying to detect and avoid on PCBs. Figure 7b is a texture-based paste-only image of the stencil in 7a highlighting the probability of paste in specific apertures and on foil surfaces. Paste in apertures is often associated with reduced amounts paste at corresponding locations on the board, and vice versa. Paste on the bottom of the stencil tends to prevent a good seal between pad and aperture and leads to poor paste definition, increased width and height, and more leakage of paste into the gap areas on both stencil and board. Figure 7c shows areas that are more likely resin than paste. Such detailed information is required to automatically configure and initiate the most appropriate corrective measures - in this case, an adaptive stencil wipe.

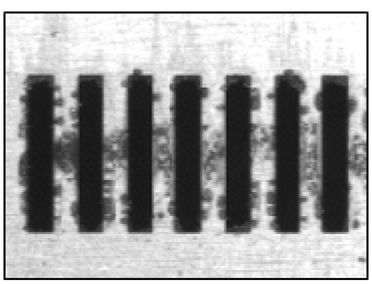

Figure 7a shows stencil contaminated with paste and resin

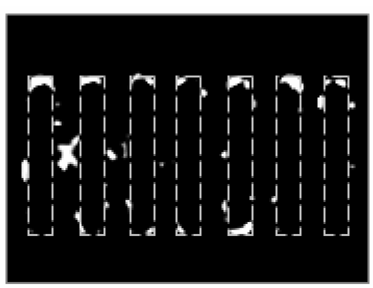

Figure 7b is a texture-based paste-only image of the stencil in 7a highlighting the probability of paste in specific apertures and on foil surfaces

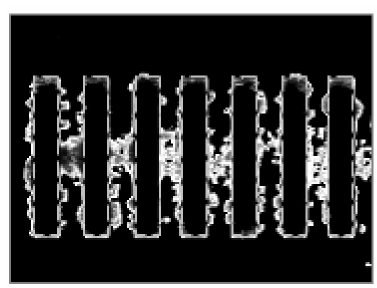

Figure 7c shows areas that are more likely resin than paste

Figure 7 – Stencil Contamination

Conclusions – Other Findings

The precise inspection of bridges is a critical tool not only for the detection of today's most common SMT print defects, but also for correcting undesirable trends in the process. Since a relatively insignificant paste-in-gap area can provide significant bridge geometry across the gap, and vice versa, both paste-in-gap and span measurements are needed to reliably determine the true significance of bridge-like features to a process.

In repeatability tests the measurement of paste-in-gap area is inherently more stable than that of span due to differences in what is being measured and the amount of data involved. Repeatability of partial span measurements is affected by the bridge detection sensitivity programmed into the system. We used what we feel to be a high level of sensitivity during our initial tests, although lower settings have proven to be more desirable in actual practice. Results are least repeatable (at 3rd standard deviation) when bridge detection sensitivity is set high and only wispy, bridge-like spans exist. In this case, fortunately, the probability of a bridge-related defect is remote, and span limits can be adjusted to avoid nuisance detection of shorter "wisps". In any case, statistical analysis would still reveal significant trends for successful process control (SPC). Of course more substantial bridge features provide more repeatable span measurement at any sensitivity setting. Our test results are published.

Additional preventive information can be provided via stencil inspection. This helps identify and initiate only the most appropriate corrective actions and maintain tight control of the process at high production speeds.

Bridge detection can only be as successful as the paste detection method used to separate paste from background. Once an appropriate paste-only image is created, this method of bridge analysis is able to provide useful and reliable measurement of bridge characteristics that are relevant to the board assembly process.

Bridge Detection

In The Solder Paste Print Process

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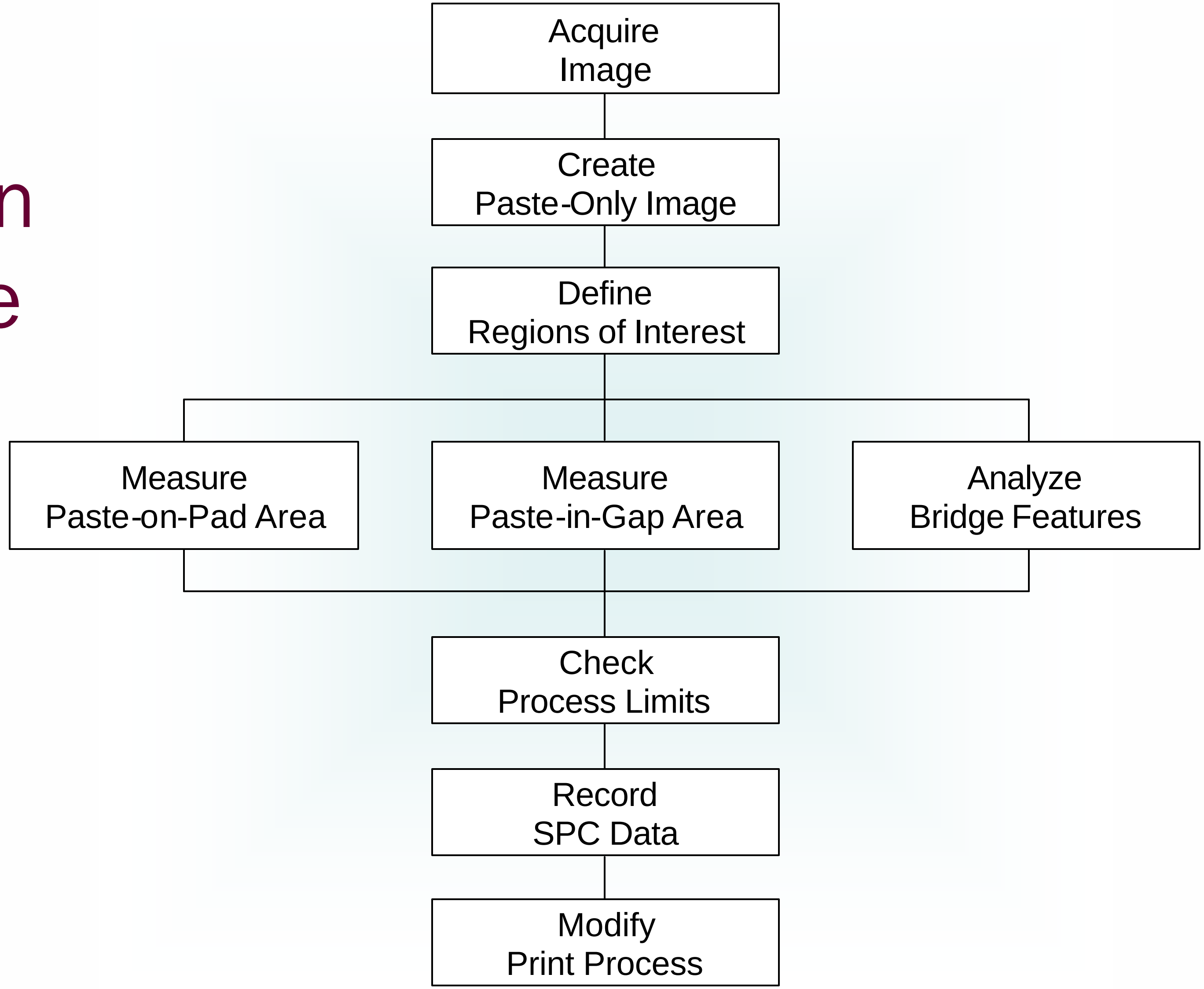
A Source of Defects

- The solder paste print operation is a recognized source of defects in surface mount assembly.

- To improve yield, defects should be detected immediately after the print operation … or at least before placement.

- The same inspection data can be used for trend analyses, adaptive process control and, ultimately, the prevention of defects.

Typical Inspection Sequence



Defect Prevention – by Design

- Prevention starts with properly designed, manufactured, and maintained boards, stencils, and paste.

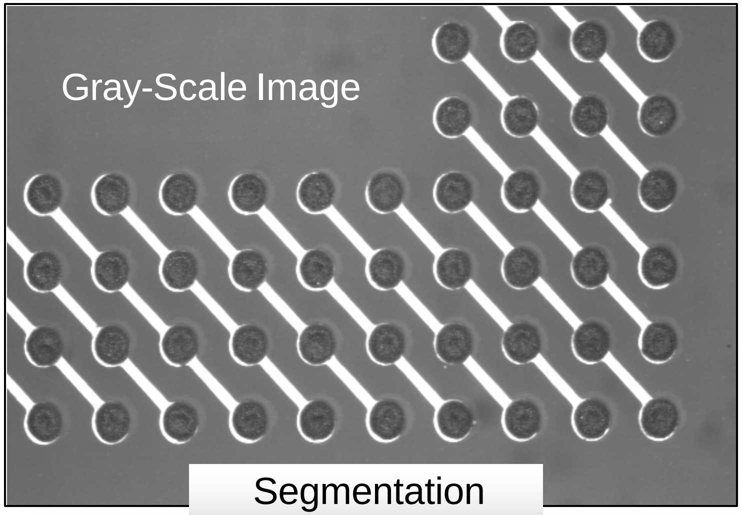
- The ability to automatically compensate for marginal or defective materials, or a fundamentally flawed design, is limited.

- Machines that are able to adapt successfully may do so with increased cycle times and a corresponding reduction in throughput.

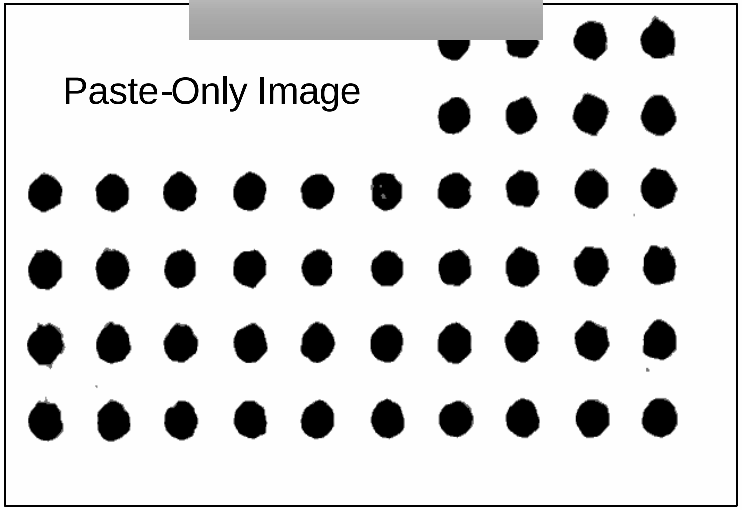
Paste Detection

An Enabling Image Process

- Any process or method that appropriately isolates paste from non-paste regions.
- A new *paste-only* image is created for subsequent analyses.
- The new image is used to determine the quantity, location, and significance of paste deposits.



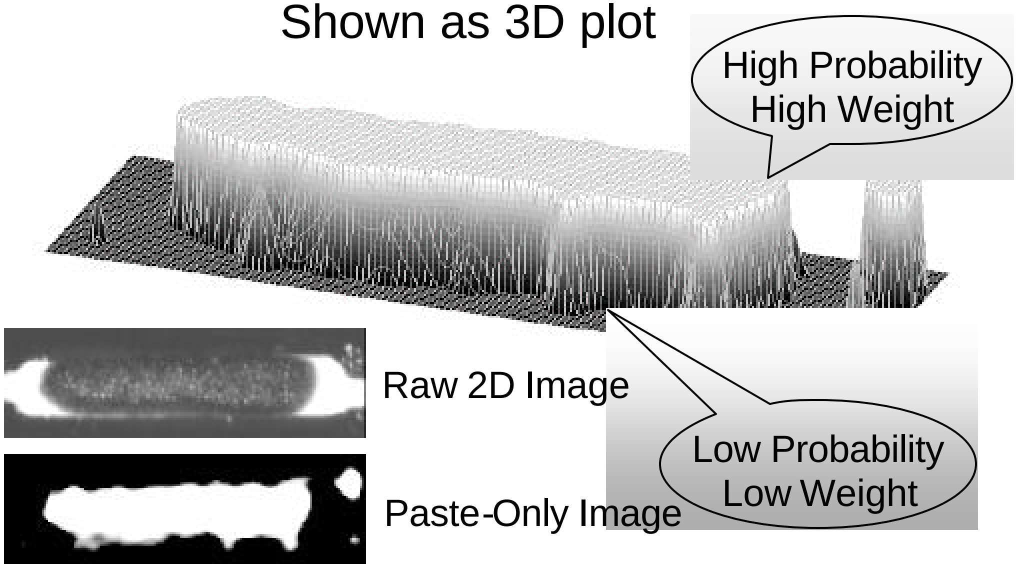
Segmentation
via Texture



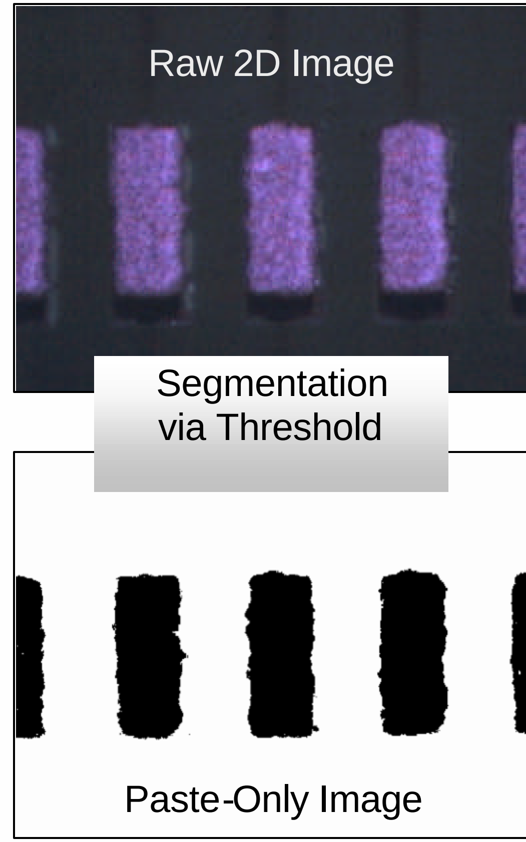
Paste Detection

An Enabling Image Process

Texture-Based
2D Paste-Only Image Data
Shown as 3D plot



UV Dye-Enhanced Paste



Bridges and Other Print Defects

Simple Definition of "Bridge"

In solder paste printing operations, the term "bridge" generally describes a print defect where some amount of stray paste spans the gap between adjacent pads.

Why Bridges are Significant

At critical dimensions, a paste bridge may fail to pull back during subsequent re-flow operations causing a short or other related defect in the final assembly.

Bridges and Other Print Defects

Other Defects …

Excess paste, poor print definition, and poor alignment also increase the probability that similar defects, notably “shorts”, may appear later in the assembly process.

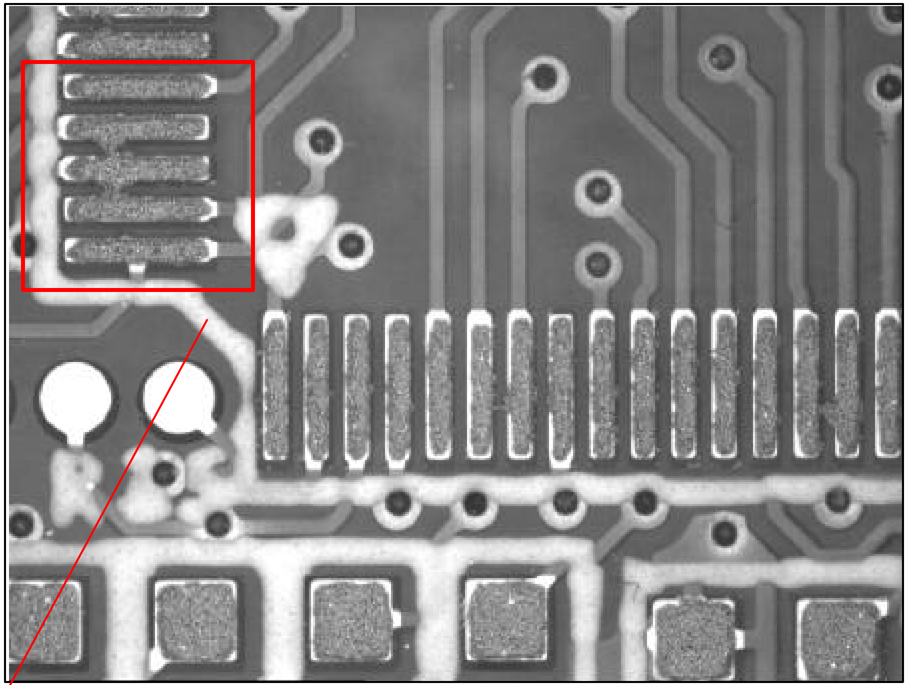
Significant Defects Vary

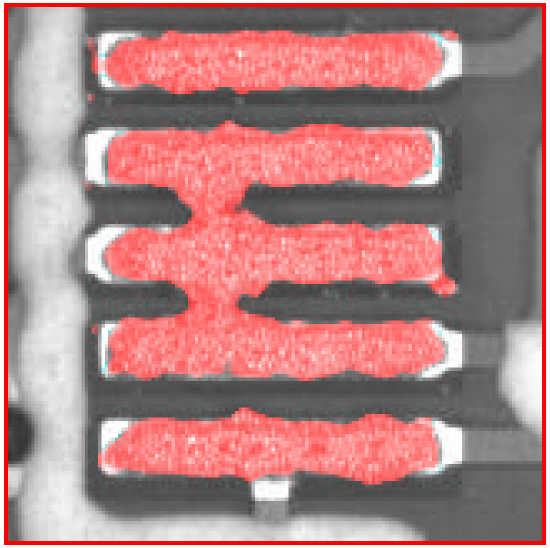
Not all bridges or bridge-like defects have the necessary mass or geometry to adversely affect a given process.

Gap defects that are, in fact, significant to a process may not always connect adjacent pads to form a well-defined bridge.

Bridge Features

... Defect Potential ?





paste spans the gap between adjacent pads

Classification Problem

Assessment of bridges, bridge-like features, and other print defects can be *a subjective task with few hard rules or limits*.

… Yet only tangible characteristics can be analyzed by a machine !

Reliable Methods are required *to*…

- Weigh significance of defects to the greater process.
- Provide meaningful output and …
- Define realistic and useful process limits.

Assessing Potential ***for a***
Bridge-Related Defect in Final PCB Assembly

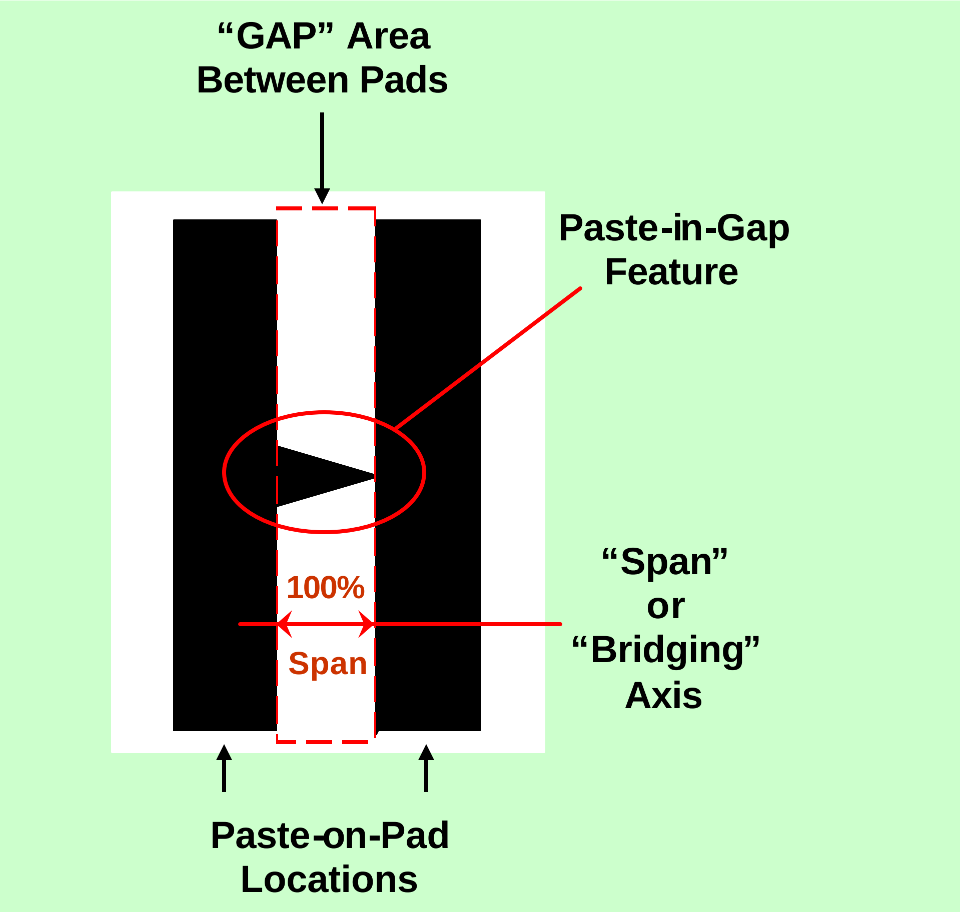
… PRACTICAL …
EXERCISE

- The following questions provide a pair of figures for subjective evaluation and estimation of defect potential.
- Each figure shows two adjacent paste-on-pad areas with a bridge-like paste-in-gap feature, or features, between them.
- The figures are CAD generated. Dimensions are relative.
- For each Question … *Indicate which of the two figures has higher potential for creating bridge-related defects, or shorts, in a completed PCB assembly.*

… PRACTICAL … EXERCISE

FIGURE FORMAT

Each figure shows two paste-on-pad areas with at least one paste-in-gap feature between them



… PRACTICAL … EXERCISE

1

Assessing Potential for Bridge-Related Defect in Final PCB Assembly

Both figures have 6% paste area in the gap.

While neither guarantee that a bridge-related defect, or short, will occur at this location …

Which has the higher potential to create such a defect ?

Answer : Ö ☐ Fig. 1A

☐ Fig. 1B

1A Must Break before Pulling Back

Break ? Pull-Back ?

Ö Fig. 1A

Paste-in-Gap
6%
Full Span
With Contact

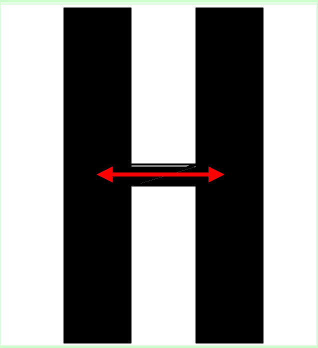
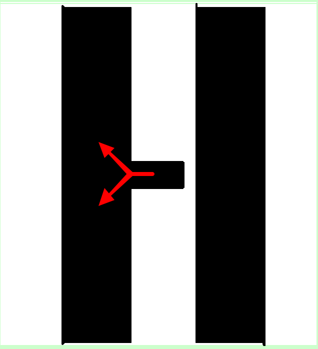


Fig. 1B

Paste-in-Gap
6%
Partial Span
No Contact



Pull-Back Only ?

… PRACTICAL … EXERCISE

2

Both figures have 6% paste area in the gap.

The paste feature in 2A is a bit narrower but is full span … with point contact.

Which has the higher potential to create a bridge related defect in the final PCB assembly ?

Answer :

Ö ☐ Fig. 2A

☐ Fig. 2B

2A has More Span and Smaller “Pulling” Base

Greater Pull-Back Distance
Smaller “Pulling” Base

Ö

Fig. 2A

Paste-in-Gap
6%
Full Span
With Contact

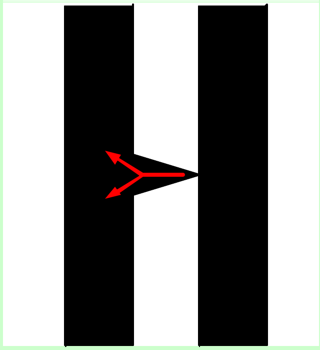
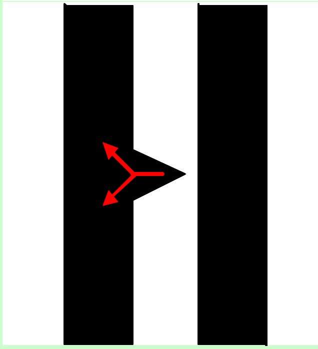


Fig. 2B

Paste-in-Gap
6%
Partial Span
No Contact



Larger Base
Less Pull-Back Distance

… PRACTICAL … EXERCISE

3

Assessing Potential for Bridge-Related Defect in Final PCB Assembly

Figure 3A has exactly 6% paste area in the gap, figure 3B has exactly 12%.

Although a bridge-related defect, or short, in the final PCB assembly is not guaranteed …

Which has the higher defect-causing potential ?

Answer :

☐ Fig. 3A

Ö Fig. 3B

Ö

Fig. 3A
Paste-in-Gap
6%
Full Span
With Contact

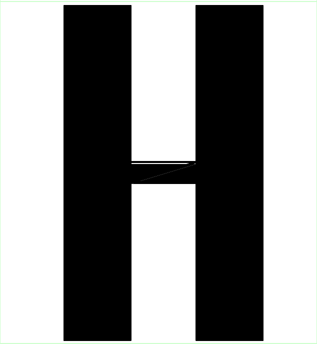
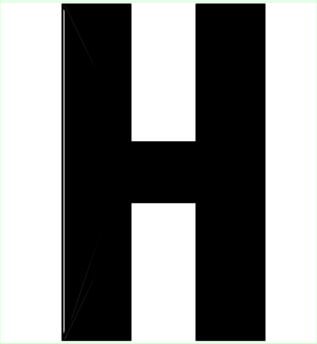


Fig. 3B
Paste-in-Gap
12%
Full Span
With Contact



Both Must Break …

3B has More Paste Area

… PRACTICAL … EXERCISE

4

Both figures have 6% paste area in the gap.

Although paste-in-Gap features have different geometry … both span 80% of the gap.

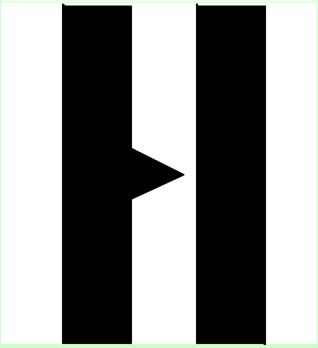
Which has a <u>higher potential</u> to create bridge-related defects in the final assembly ?

Answer :

- ☐ Fig. 4A
- ☐ Ö Fig. 4B
- ☐ Both have same potential

Fig. 4A

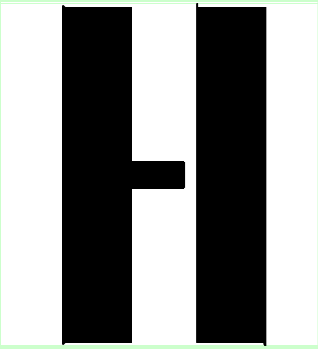
Paste-in-Gap
6%
Span
80%



Ö

Fig. 4B

Paste-in-Gap
6%
Span
80%



Same Span, Same Paste Area … Different Geometry

… PRACTICAL … EXERCISE

5

Both figures are examples of overprint …
possibly due to poor stencil-to-pad seal during print … or a paste-smeared stencil.

Neither figure has classic bridge-like geometry.

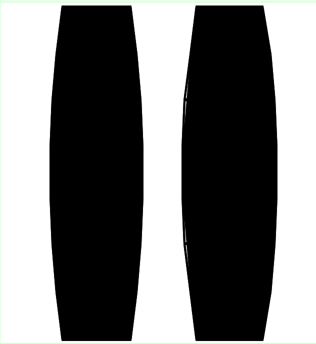
Which figure has a <u>higher potential</u> to create a bridge-related defect, or short ?

Answer :

- ☐ Fig. 5A
- Ö Fig. 5B
- ☐ Both have same potential

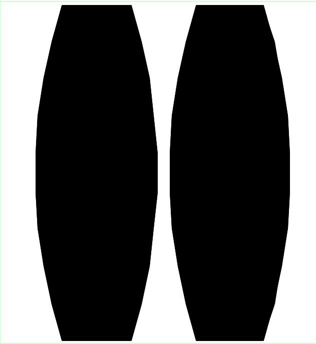
More Bridge Potential ? Yes !

Fig. 5A
Paste-in-Gap
27% total
Equiv. Span
40%



Ö

Fig. 5B
Paste-in-Gap
55% total
Equiv. Span
80%



… PRACTICAL … EXERCISE

6

Both figures are examples of misalignment … perhaps indicating poor stencil-board fit, or “stretch”, or movement during print.

Neither figure has classic bridge-like geometry.

Which figure has a higher potential to create a bridge-related defect, or short ?

Answer :

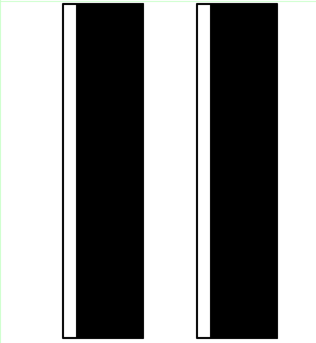
- ☐ Fig. 6A
- Ö Fig. 6B
- ☐ Both have same potential

More Bridge Potential ?

Yes !

Fig. 6A

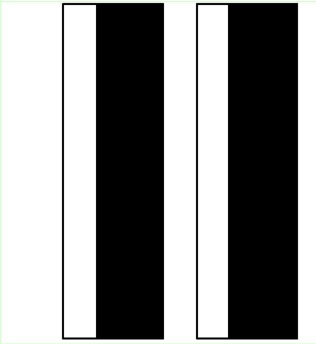
Paste-in-Gap
20% total
Equiv. Span
20%



Ö

Fig. 6B

Paste-in-Gap
50% total
Equiv. Span
50%



… PRACTICAL … EXERCISE

7

Assessing Potential for Bridge-Related Defect in Final PCB Assembly

PASS

Figures 7A and 7B have exactly 1[illegible]% total paste area in the gap.

All features reach 80% across the gap.

Which figure has a higher potential to create a bridge-related defect in the final assembly ?

Answer :

☐ Fig. 7A

☐ Fig. 7B

Ö ☐ Both have same potential

SAME Potential

Ö

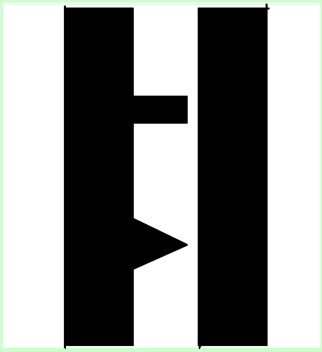


Fig. 7A

Paste-in-Gap 6% each
Both Span 80%

Ö

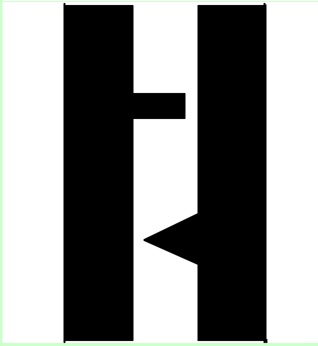


Fig. 7B

Paste-in-Gap 6% each
Both Span 80%

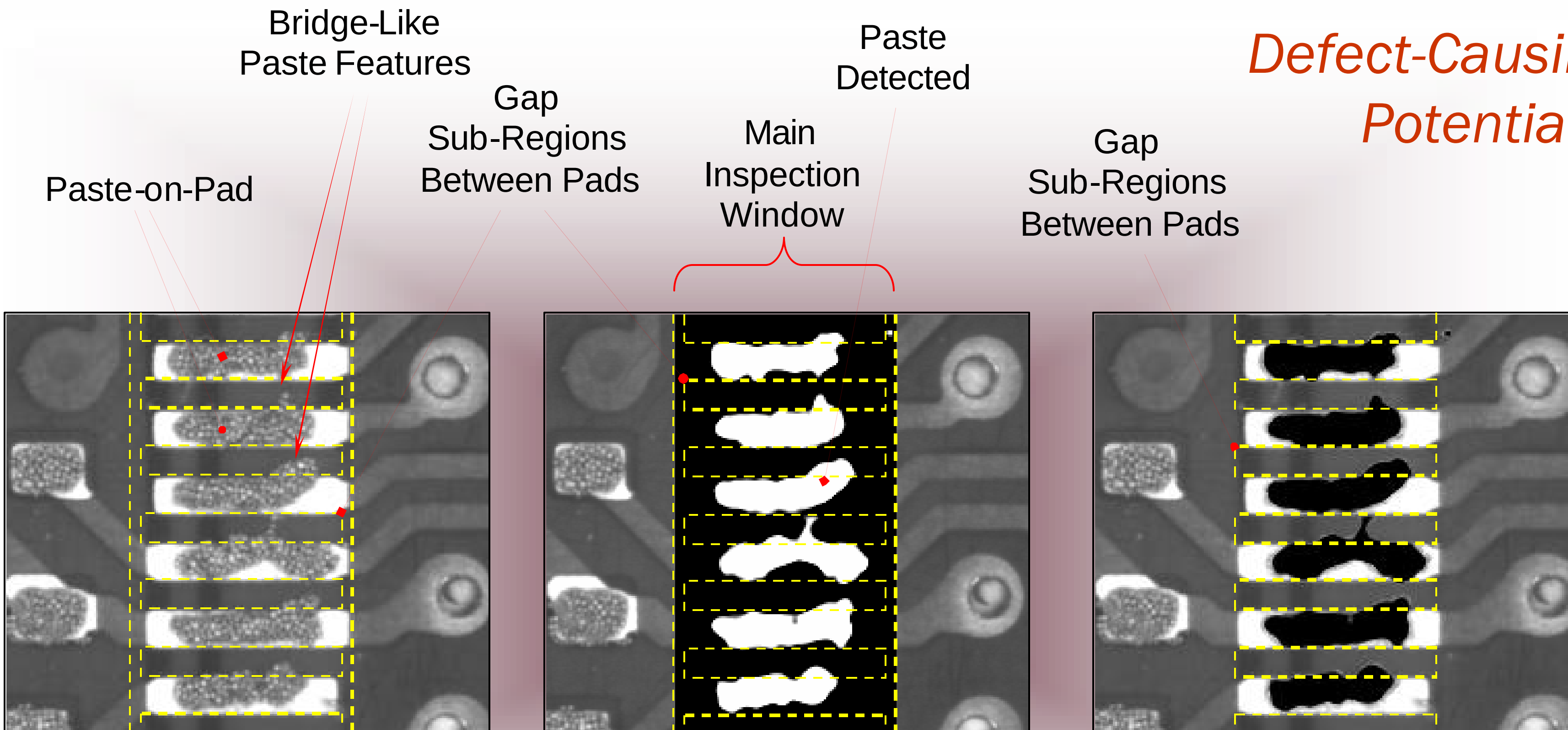
Same Net Bridge Potential … Mirrored Geometry

Bridge Detection and Prevention

Detection occurs when a single measurement, or data point, exceeds user defined limits.

- The offending process is usually stopped for visual confirmation by an operator.
- As an option, or in "lights out" operation, boards can be rejected without operator intervention.

Prevention is based on the same data as Bridge detection. Statistics identify undesirable trends … usually over time.



Defect-Causing Potential ?

Raw Image A
Cropped for Display
(Defects Manually Introduced)

Probability Image B
via Texture-Based Method
White Paste - Gray Edges

Overlay Image A and B
as demonstration of
Paste Detection Capability

Example: Probability (Paste-Only) Image with Gap Regions of Interest

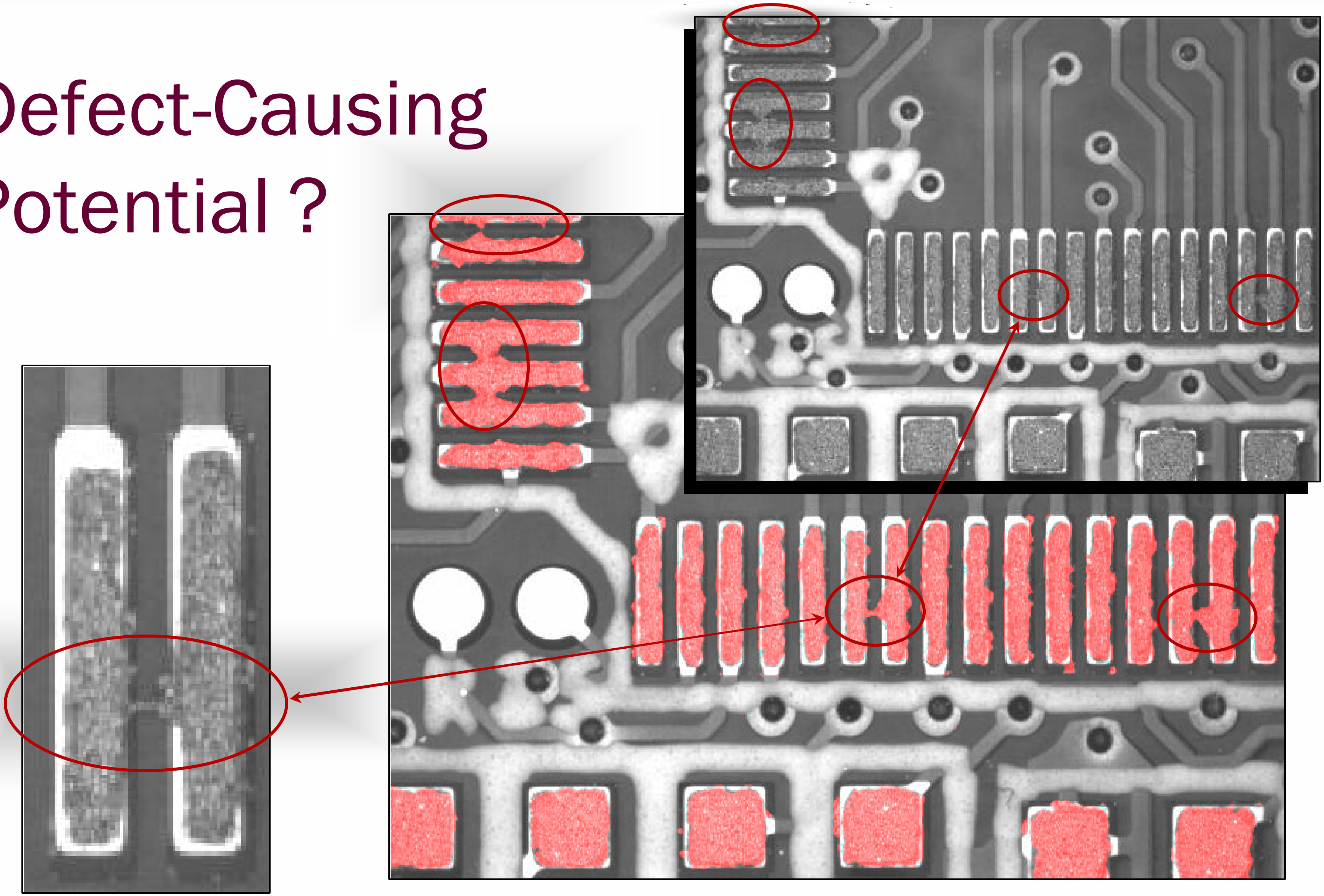
Paste-in-Gap Area and Bridge-like Geometry

Unique Gap Analysis is Required to …

- Provide Reliable Paste-in-Gap Area Measurement
- Detect Significant Bridge-Like Paste Geometry

… Must Relate to the Assembly Process

Defect-Causing Potential ?



Simple User-Defined Bridge Detection Parameters

User-Defined Input is Reduced to the Following …

1) **Maximum Paste-in-Gap Area** … percent of total gap area

2) **Low, Medium, or High Sensitivity** … for bridge detection

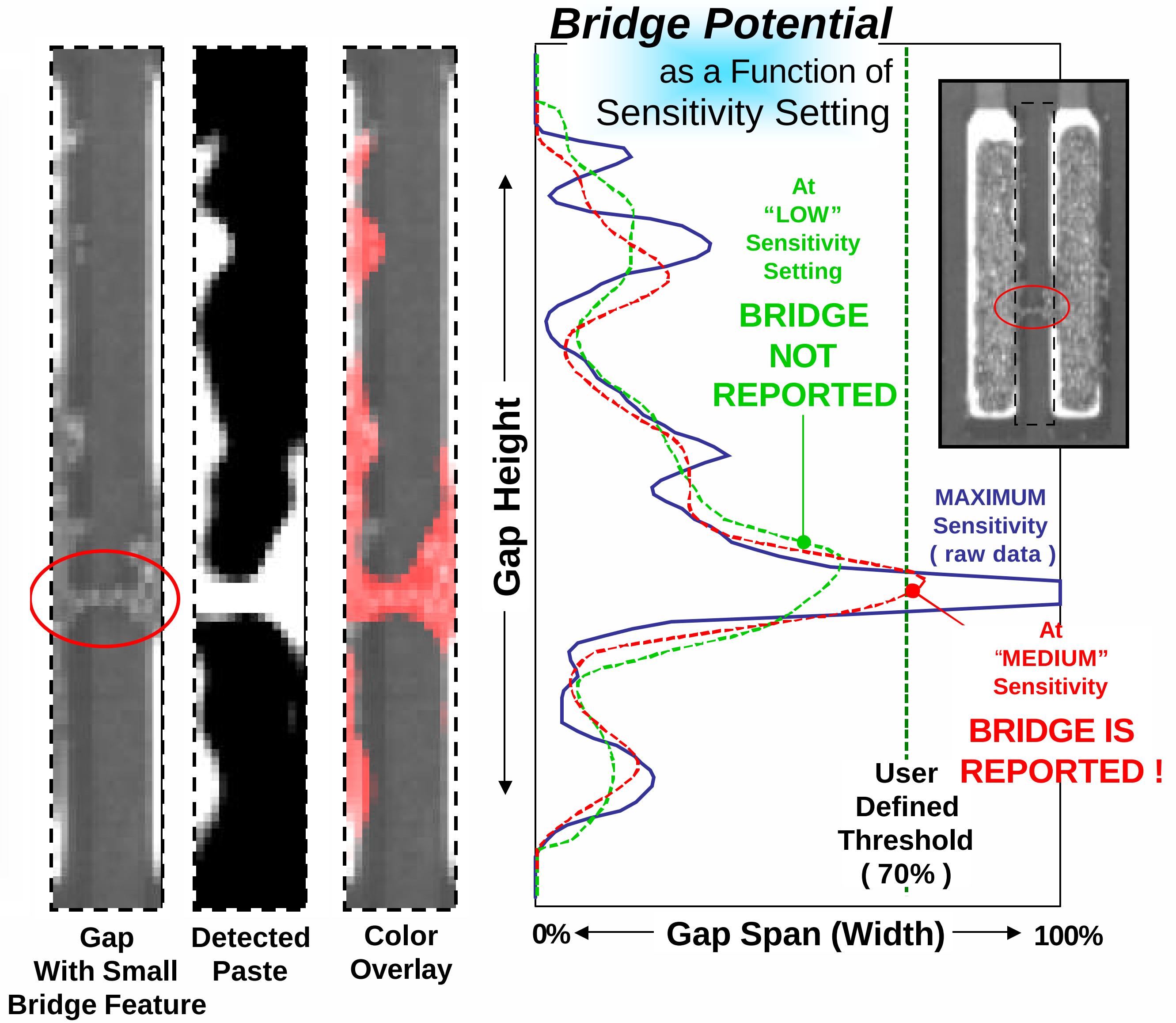
3) **Maximum Span** … of bridge-like features as percent gap width

Bridging Potential

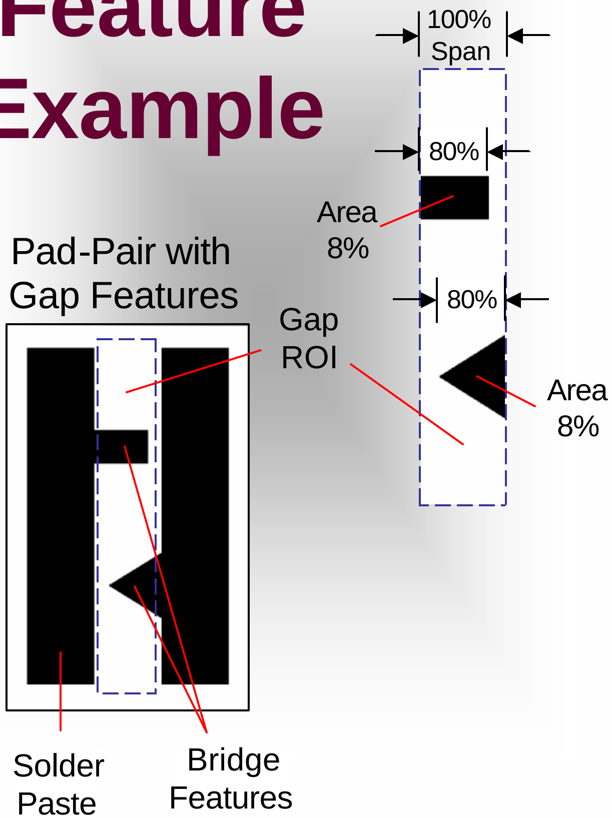
Reported as
a Function of

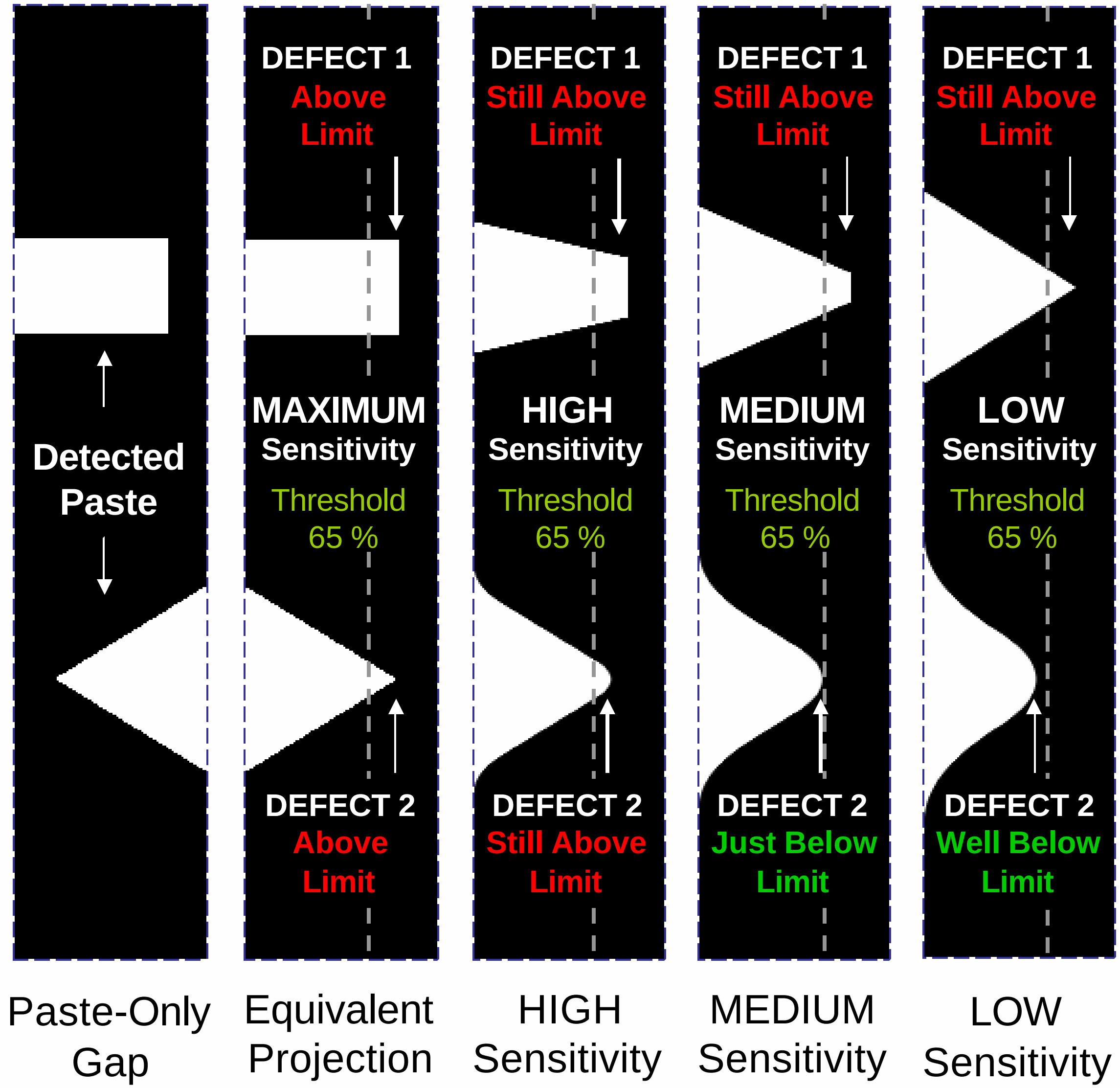
User-Defined

Sensitivity Setting



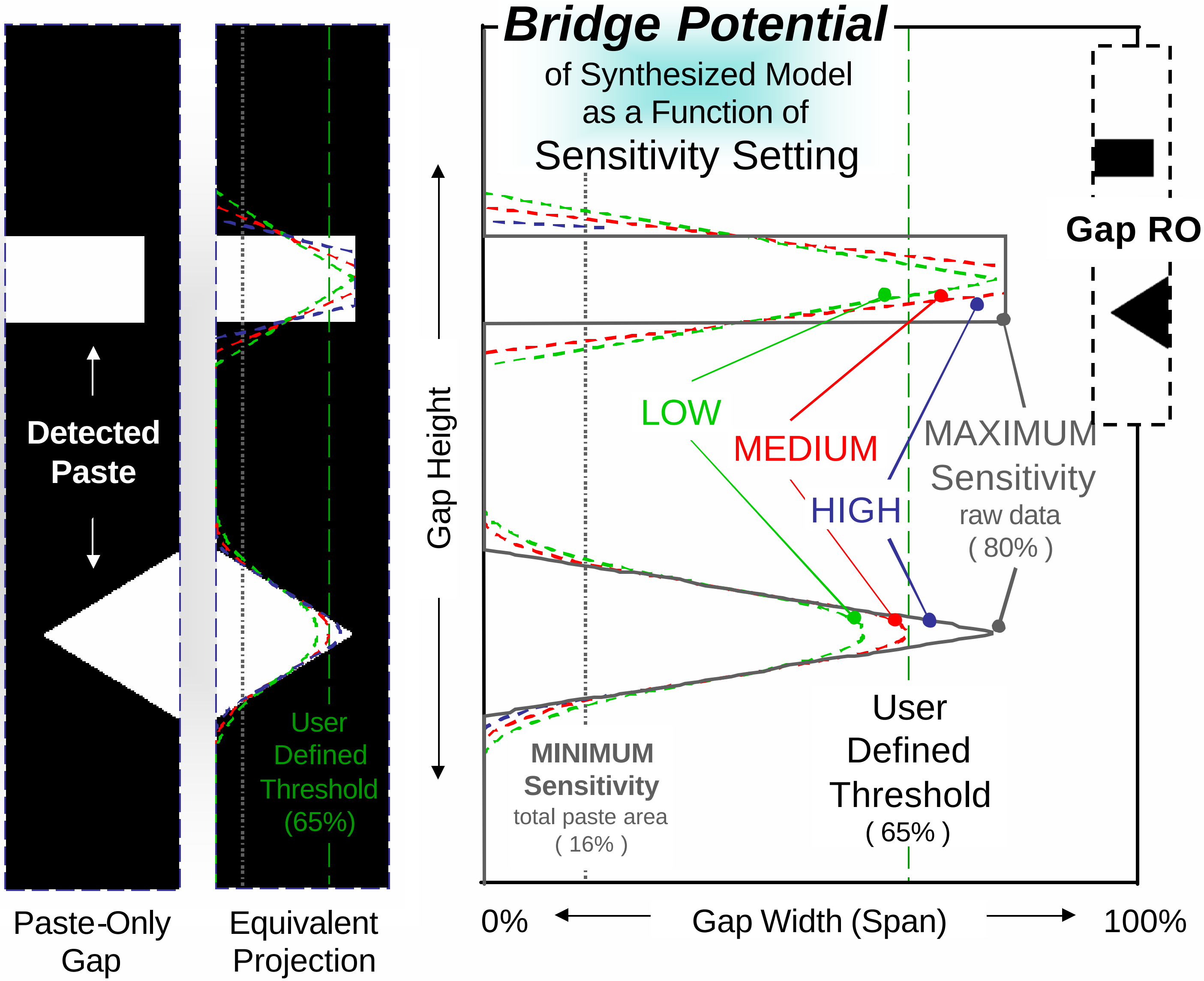
Multi-Feature Example





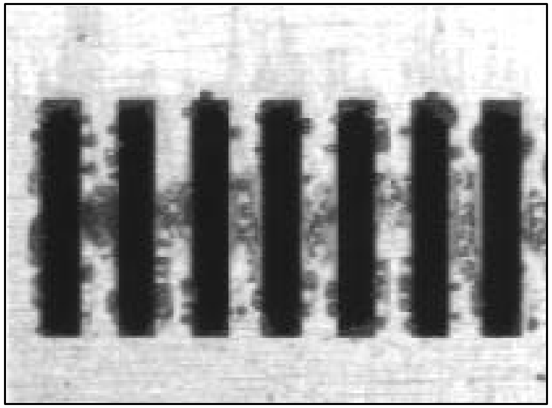
Multi-Feature Example

Equivalent Profiles at User-Defined *Sensitivity*

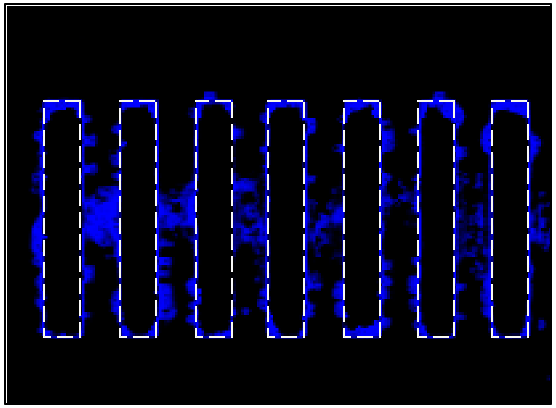


Additional Means of Prevention

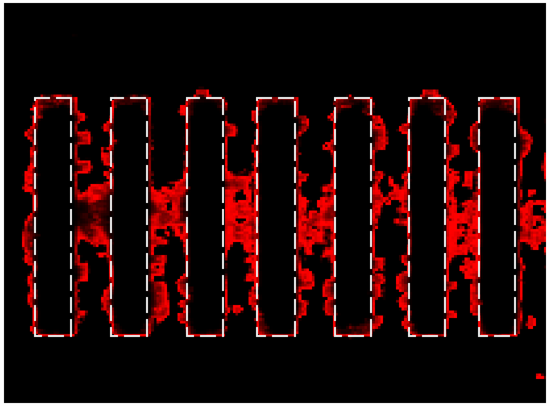
STENCIL INSPECTION **can provide additional preventive information …**



stencil with paste and resin

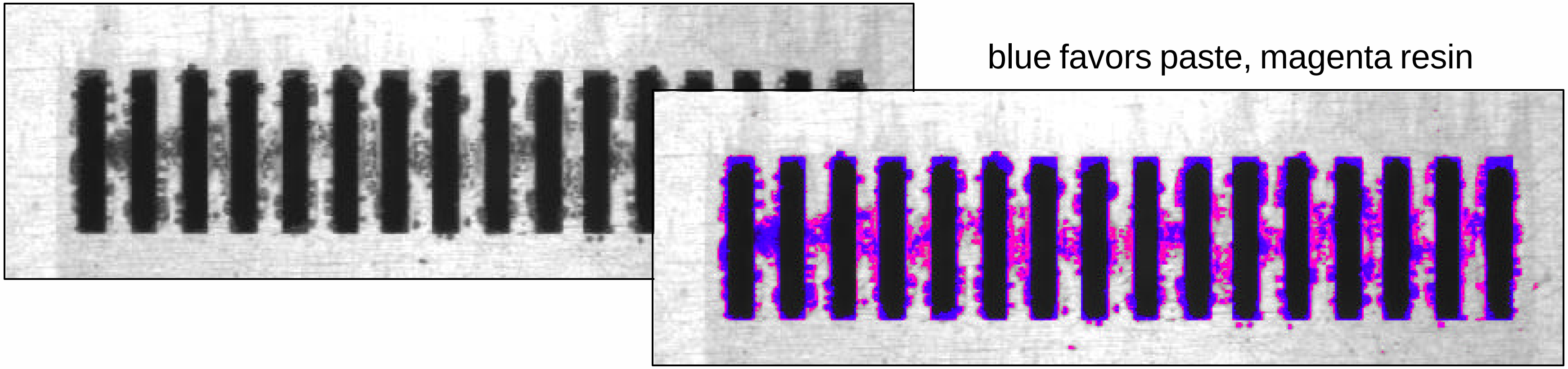


more likely paste



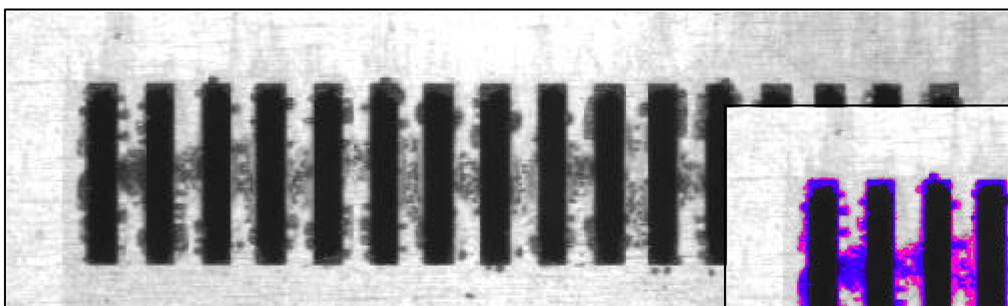
more likely resin

blue favors paste, magenta resin

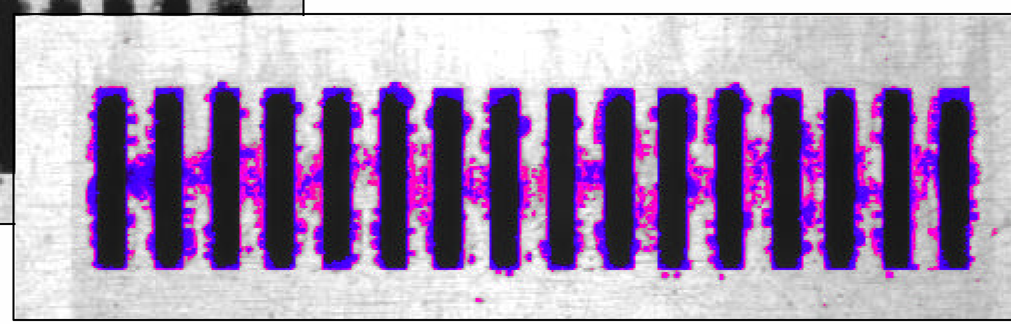


Stencil Inspection

- Stand-alone AOI machines have no access to the stencil during production
- Inspection and Paste Deposition are exclusive events inside the printer ... avoid unnecessary inspections
- Use well-targeted sampling to spot trends and to identify probable cause of defects found on the PCB



stencil with paste and resin



blue favors paste, magenta resin

Conclusions – Other findings

- Post-Print inspection is a valuable tool for detecting defects and undesirable trends in the *print process*.
- Reliable methods are required to identify and weigh the significance of print defects *as they relate to the assembly process*.
- Stencil inspection can provide additional *preventive* information.

Conclusions – Other findings

- Relatively *insignificant paste-in-gap* area can have *significant bridging geometry* across the gap.

- *Significant paste-in-gap* area may have relatively *insignificant gap-bridging geometry*.

- Both measurements are needed to reliably determine the true significance of bridge-like features to the *print and assembly process*.

Conclusions – Other findings

- Measurement and detection of *finer bridge features* is affected by *sensitivity* programmed into the system.

- More substantial bridge features provide more consistent measurement and detection *at any sensitivity setting*.

- In any case, statistics reveal significant trends for successful print process control.

Conclusions – Other findings

- The bridge detection analysis can only be as successful as the method used to separate paste from background. Once a *suitable* paste-only image is created …

This method of bridge analysis provides useful measurement of characteristics relevant to the assembly process

Bridge Detection

In The Solder Paste Print Process

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