AN IMPROVED AUTOMATED SPI DATA ANALYSIS REPORT GENERATOR FOR PRINTED CIRCUIT BOARD ASSEMBLY

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Outline/Agenda

- Introduction
- Methodology
- Results & Conclusion
- Acknowledgements

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Introduction

- Solder Paste Inspection:
  - Inspect solder paste deposition across all Cu pads in the PCB
- SPI machine output: Volume, Area, Height
- Need to perform analysis to determine optimal printing parameters
- Need to keep monitor SPI throughout the build
- Need to create comprehensive reports

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1	No	BoardN	Barcode	Time	Job	Result	User	Line	Lot	Carrie	Panel	Lane	SQ															
2	1	1	1.58E+12	2022/08/30 20:41:35	610-1	RPAS	1E+05	SJS1A	NONE	NONE	NONE	N	F															
3																												
4	Compon	PAD ID	Volume(r	Volume(%)1	Area(r	Area(%	Heigh	Heigh	Offset	Offset	Angle	Spec F	Spec F	Offset	Offset	Area L	Area L	Volun	Volun	Volun	Volun	Heigh	Heigh	Heigh	Offset	Offset	Pad W(mm)1	Pad H(mm)1
5	C1_1	1	0.07489	100.89	0.711	97.66	0.105	103.3	4.69	21.21	0	1.252	0.702	-1.88	15.37	50	200	0.037	50	0.89	200	100	200	50	-1.87	15.11	1.2499	0.69
6	C1_1	2	0.08621	116.28	0.719	98.9	0.12	117.6	6.14	1.45	180	1.252	0.702	2.4	-1.04	50	200	0.037	50	16.28	200	100	200	50	2.453	-1.03	1.2799	0.7
7	C10_1	1	0.01808	105.22	0.149	88.28	0.122	119.2	5.07	14.89	0	0.502	0.402	-5.4	19.09	50	200	0.009	50	5.22	200	100	200	50	-5.05	18.52	0.47	0.39
8	C10_1	2	0.01789	104.33	0.139	82.57	0.129	126.4	4.39	2.6	180	0.502	0.402	4.672	-3.71	50	200	0.009	50	4.33	200	100	200	50	4.374	-3.23	0.47	0.35

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Introduction

- The proposed setup is not only about SPI data analysis, but about **process automation**

- **Two in one:**
  - **Quick Printing DOE setup**: optimization of printing parameters (< 20 min)
  - **SPI Evaluation setup** (In Seconds)

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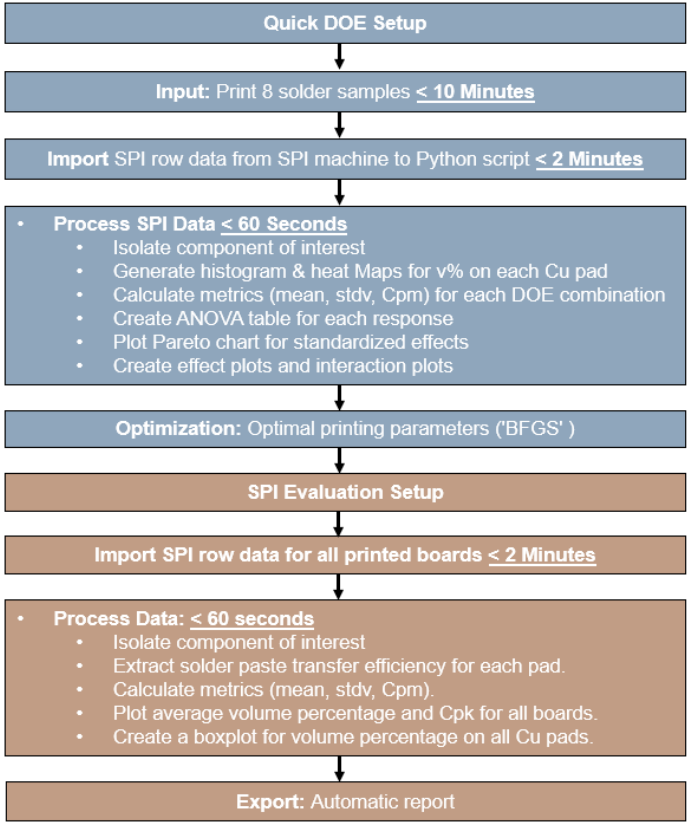
Methodology

- Flowchart:



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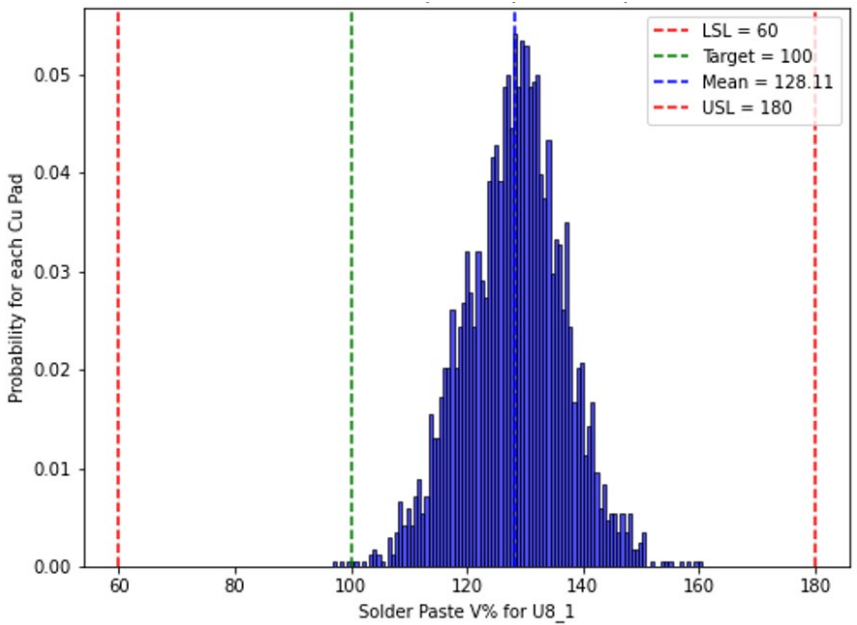
Methodology

- Obtain optimal printing parameters based on C_{pm} capability index
- C_{pk} index assume equal distance from specs to the target (T)



$$C_{pm} = \frac{\mathrm{USL} - \mathrm{LSL}}{6\sqrt{\sigma^2 + (\mu - T)^2}}$$

$$C_{pk} = \mathrm{Min}\left[\frac{\mathrm{USL}-\mu}{3\sigma}, \frac{\mu-\mathrm{LSL}}{3\sigma}\right]$$

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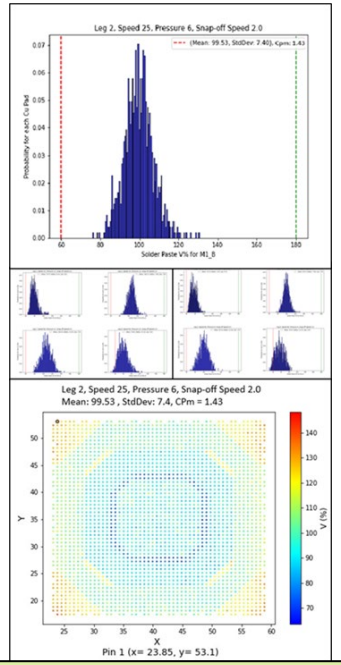
Methodology

- Printing **DOE** Setup: Full Factorial Design

Table 1. Multi-response full factorial DOE design table

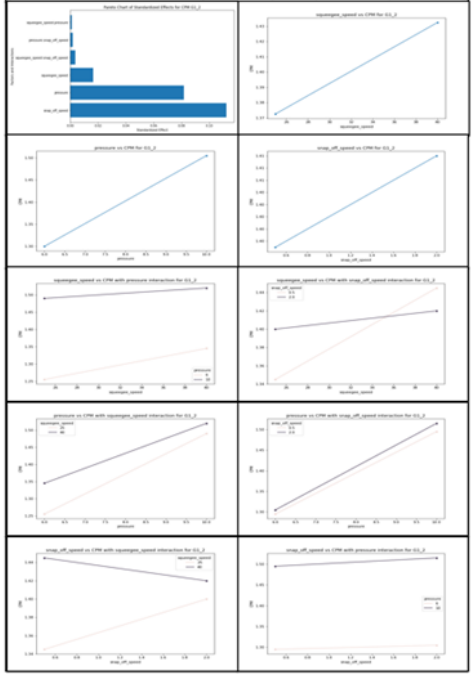
Leg	Squeegee speed (mm/s)	Pressure (Kgf)	Snap off speed (mm/s)	Mean_V (%)	STD_V	C_{pm}
1	25	6	0.5	87.6	10.74	1.22
2	25	6	2	88.7	10.74	1.28
3	25	10	0.5	91.6	10.55	1.49
4	25	10	2	92.2	10.49	1.53
5	40	6	0.5	90.1	10.23	1.41
6	40	6	2	89.4	10.4	1.34
7	40	10	0.5	91.8	9.96	1.55
8	40	10	2	91.6	9.39	1.58

DOE Design



Response for each Treatment

Source (G1_1)	sum_sq	df	F	PR(>F)
squeegee_speed	0.81	1	13.95	0.17
pressure	0.37	1	6.40	0.24
snap_off_speed	0.03	1	0.46	0.62
squeegee_speed:pressure	0.09	1	1.53	0.43
squeegee_speed:snap_off_speed	0.01	1	0.25	0.70
pressure:snap_off_speed	0.08	1	1.38	0.45
Residual	0.06	1		



ANOVA & DOE Output

$$obj. = w_1 \times (V\%\ mean - 100\%)^2 + w_2 \times V\%\ std - w_3 \times C_{pm}$$

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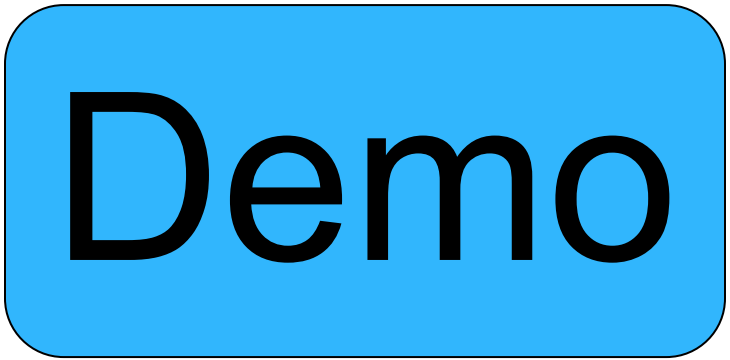
Methodology

- Printing **DOE** Setup



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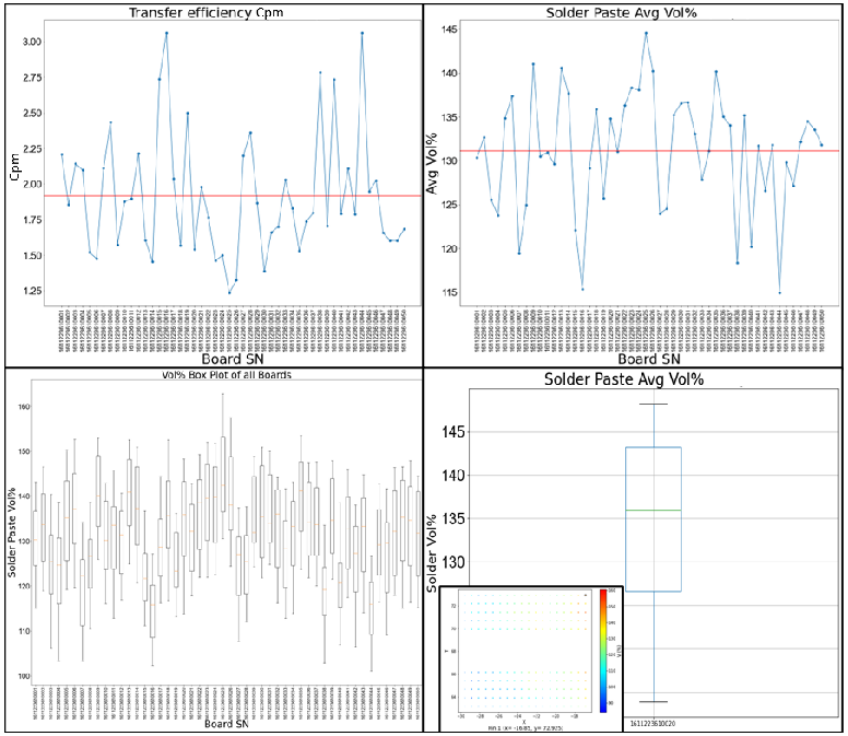
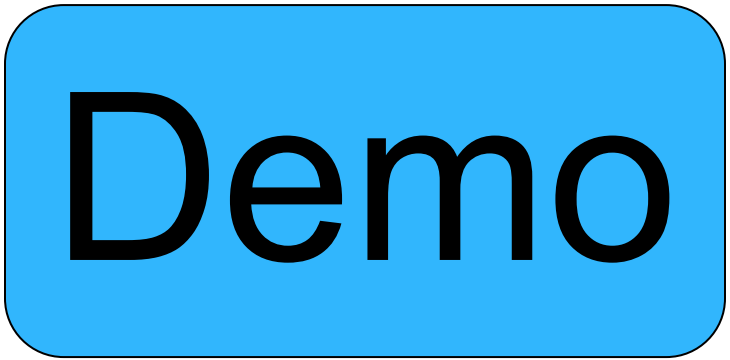
Methodology

- SPI **Evaluation** setup
- Continuous SPI monitoring across the build
  - Per component
  - Per Zone (Color Maps)



Methodology

- SPI **Evaluation** setup



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Results & Conclusion

- This proposed Setup:
  - Rapidly identifies optimal SMT printing parameters
  - Provides ongoing SPI monitoring
  - Automatically generates reports
  - Suitable for the complexities and fast-paced demands of contemporary electronics manufacturing.

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THANK YOU!

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