CLOSING THE GAP: RESOLVING MEASUREMENT MISMATCH THROUGH A COLLABORATIVE MEASUREMENT SYSTEM ANALYSIS

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ABSTRACT

Dimensional mismatches in critical features led to 100% rejection rates and costly delays during Customer N's incoming inspections for multiple orders hampering new products' time to market. With the customer's strategic importance and production timelines at stake, the root cause was traced to a misalignment in measurement systems: Cohu employed a Drop Gauge with manual fixture, while Customer N used a Vision Measuring Machine (VMM). In response, a collaborative Measurement System Analysis (MSA) was launched to close the gap through data-driven methods and engineering alignment.

Over a span of ten weeks, both sites conducted Gage Repeatability and Reproducibility (GR&R) and correlation studies using fabricated metal master samples. Initial results revealed inconsistencies caused by equipment variability, unstable fixturing, and non-uniform reference points. To resolve this, the team introduced a latch-type fixture to secure the parts and standardized the measurement locations across both factories. This refined approach improved GR&R and yielded statistically acceptable correlation ($p > 0.05$), enabling unified measurement outcomes. When applied to subsequent orders after the study, the result was full acceptance, no rejections, no delays. Beyond resolving the immediate issue, the initiative established a scalable measurement standard, reinforcing quality and alignment for future builds.

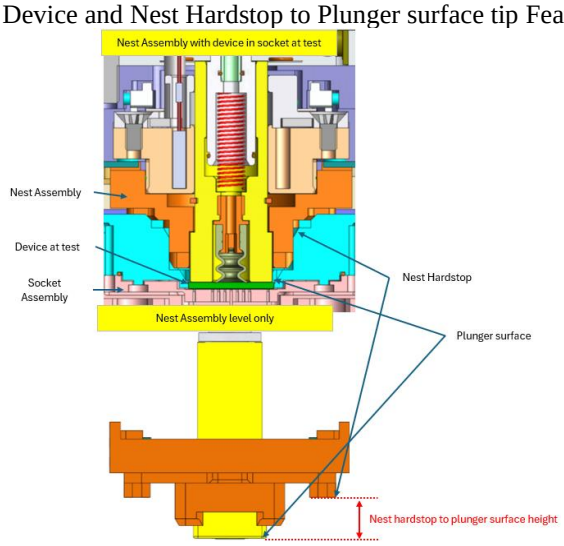
1. 0 INTRODUCTION

1.1 Problem Background

Measurement mismatches between supplier and customer inspection systems may appear as isolated quality issues, but in high-precision manufacturing environments, they can escalate into significant customer's operational and scheduling risks. This was the case for Cohu and Customer N, where recurring discrepancies in height measurements of nest assemblies led to multiple 100% rejections for multiple orders that led to weeks of shipment delays, and extended buy-off timelines. As critical components in semiconductor pick-and-place handlers, these assemblies play a vital role in test accuracy and production flow. More importantly, the issue exposed a broader challenge in aligning measurement systems across sites— a risk that extend beyond this specific case and could impact future products, customers, and cross-factory operations if not addressed.

Nest assemblies are precision-engineered plastic parts, typically made from materials like Torlon or Semitron. These assemblies are designed to accurately position devices before and after testing in semiconductor handlers. Among the critical features is the height from the nest hard stop to the plunger tip surface, as this directly controls the device's plunger depth during testing. Even minor variances in this value can compromise test reliability, which is why stringent inspections are enforced by customers during incoming quality checks.

Fig. 1 Cross section view of Nest assembly during test with Device and Nest Hardstop to Plunger surface tip Feature



Customer N is the major customer of Nest Assembly and is one of the key customers of Cohu located in Taiwan who performs strict quality control wherein delivered parts were measured during incoming inspection using available measurement equipment on site that is a vision measuring machine (VMM). Customer N had complaints on three (3) cases with the same issue which complained about the Nest Hardstop dimensions that are either beyond or lower than the specification drawing requirements when measured at their VMM.

Fig.2 Customer N VMM and its method wherein the Nest Assembly is placed on gauge block. The inspector subtracts the measured height of the hardstop portion from the block where it was placed and the measured the height of the plunger tip from the block it was placed. The difference is the hardstop dimension being recorded by customer.

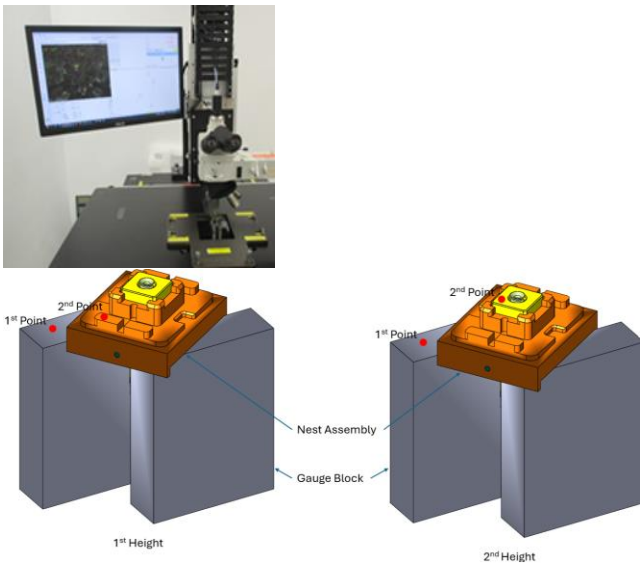


Fig.3 Customer N complaint measured dimension on hardstop nest samples of the most recent batch complaint. The image shows 7 out of 8pcs samples measurement record that are non-compliant to specification. The specification is 6.080 to 6.100mm.

L9	
前1	前2
6.106	6.105
後3	後4
6.104	6.1

L10	
前1	前2
6.072	6.078
後3	後4
6.075	6.065

L11	
前1	前2
6.084	6.076
後3	後4
6.081	6.086

L12	
前1	前2
6.067	6.073
後3	後4
6.088	6.086

L15	
前1	前2
6.103	6.102
後3	後4
6.116	6.113

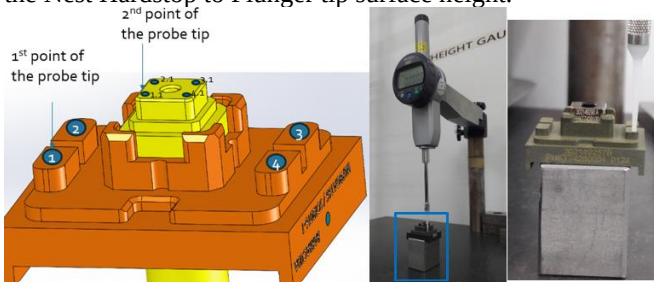
L16	
前1	前2
6.103	6.088
後3	後4
6.116	6.111

R1	
前1	前2
6.080	6.086
後3	後4
6.088	6.089

R2	
前1	前2
6.08	6.067
後3	後4
6.097	6.094

Before shipping to the customer, those complaint Nest Assemblies did undergo outgoing measurement using Drop Gage to measure the hardstop dimension. However, those nest assemblies passed the outgoing quality check that resulted in conflict of judgement between two sites.

Fig.4 Cohu Drop Gage method using a fabricated block to place the nest assembly during measurement. The operator points the tip on hardstop point, re-zero the Drop Gage dial before pointing to the plunger tip surface. The value will be the Nest Hardstop to Plunger tip surface height.



L9	
P1	P2
6.099	6.086
P3	P4
6.091	6.081

L10	
P1	P2
6.100	6.096
P3	P4
6.083	6.073

L11	
P1	P2
6.100	6.100
P3	P4
6.099	6.086

L12	
P1	P2
6.086	6.099
P3	P4
6.091	6.091

L15	
P1	P2
6.086	6.091
P3	P4
6.093	6.088

L16	
P1	P2
6.099	6.100
P3	P4
6.086	6.093

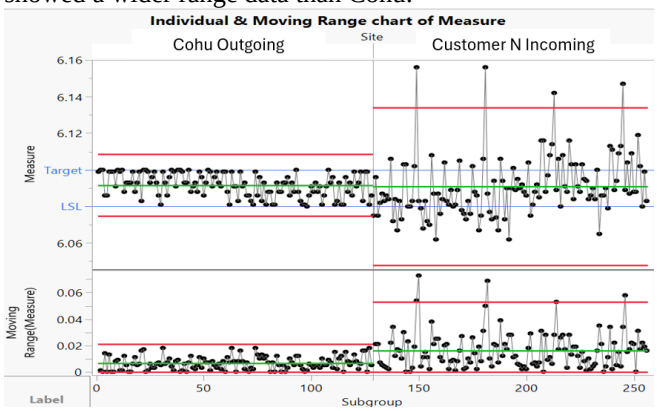
R1	
P1	P2
6.086	6.088
P3	P4
6.086	6.088

R2	
P1	P2
6.099	6.099
P3	P4
6.083	6.091

2.1 Correlation and Difference of Cohu and Customer N measurement

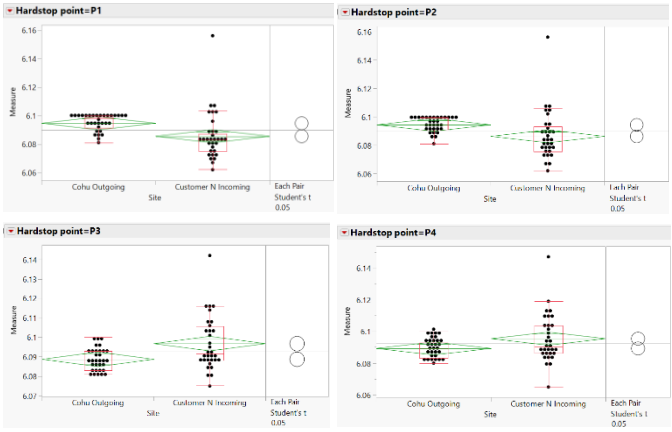
Differences in measurement data between Cohu and Customer N resulted in a conflict on judgment that gave risk to production delay of the parts since several points were out of specification at Customer N.

Fig. 5 Using I & MR Chart at JMP, showed the measurement range of both factories compared. Customer N measurement showed a wider range data than Cohu.



Correlation checking also on both factories measurement showed a significant difference that needs to be addressed to eliminate such issues on conflict of result at Customer N incoming and Cohu outgoing.

Fig.6 Using JMP, performed One way analysis and using Each pair Student t-Test checks on Cohu and Customer N measurement per Nest Assembly Hardstop points (P1 to P4). p-Value range from 0.004 to 0.038 less than the target of more than 0.05.



2. 0 REVIEW OF RELATED WORK

Measurement System Analysis (MSA) is used to determine the sustainability of a measurement system since this is a tool for analyzing the variation present in each type of inspection, measurement, and test equipment.

The study followed specific phases of getting baselines of each site's current systems, stabilize those measurements, look and perform for methodologies that have good GR&R and are correlated with each system and finally standardize those identified and proven methodologies with passing GR&R and correlation.

One-way analysis of variance (T-Test) is used to test correlation as this is a statistical method for testing differences in the means of three or more groups.

3.0 METHODOLOGY

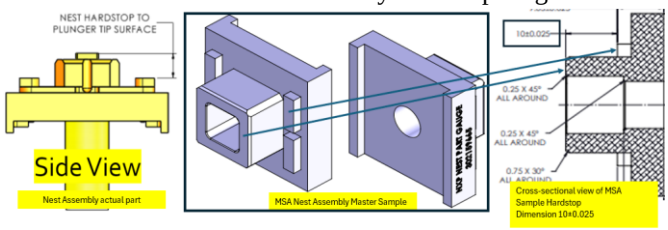
2.1 Measurement System Analysis (MSA)

A measurement system analysis activity was performed between the two sites to evaluate the methodology, measuring instruments used, understanding the measurement error and identify steps the two sites can implement to align the measurements.

2.1.1 Baseline

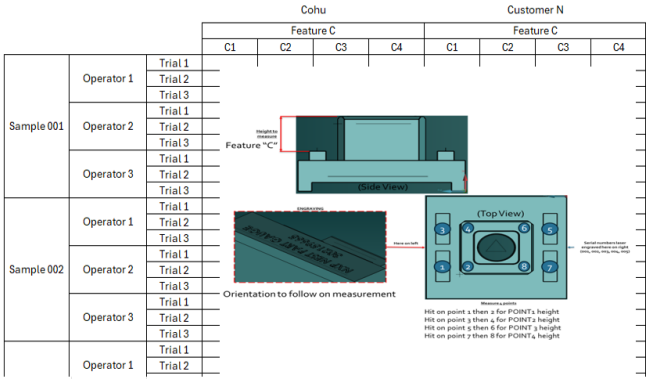
Started on metrologies used by both sites and checking that those are compliant and within standards. Then master samples also were designed and fabricated to be used for this MSA activity with Customer N. The team designed part-samples with the same nest assembly hardstop feature concept and made of metal to eliminate any factor of material change during the activity process. A total of 5pcs samples were made for getting the baseline measurements of both sites.

Fig.7 Nest Assembly MSA Master samples with features same with the actual Nest Assembly Hardstop height.



To get the baseline, the team used all 5 samples, each sample was measured by 3 different operators. Each operator measured each sample 3 times with randomized sampling sequence. Features and measurement points were defined, wherein 4 different points of the hardstop feature of the MSA sample were selected to be verified. Baselining was conducted first at Cohu site before shipping out samples to Customer N for the same approach also.

Fig.8 MSA Baseline measurement points showing the 4 different Hardstop points on sample to be measured, its required orientation and the datasheet used.



2.1.2 Stabilization

Once baseline measurement records were completed on both sites. The team performed GR&R study to check if current methodologies were capable and within acceptable criteria.

If GR&R fails, the specific site that failed will analyze and do necessary changes in methodology to pass the criteria until both sites passed.

Afterwards, perform correlation study using One-way analysis – T-test of those methods that both factories able to pass the GR&R. The criteria are as follows:

Acceptable: p-Value is more than 0.05
Not acceptable: p-Value is less than 0.05

Stabilization objective is for both sites to have methods that will pass GR&R and have correlation with each other. If not, changes in method will be required until both pass the two studies.

2.1.3 Alignment

After both sites pass the stabilization stage by identifying the methodology that passes the GR&R and correlation study, those methodologies will be aligned between two sites. Fixturing and instructions will be released also based on the identified acceptable methodology.

Alignment objective is to conduct the method identified to be correlated for both sites for implementation and verify the live result.

4.0 RESULTS AND DISCUSSION

3.1 Measurement System Analysis (MSA)

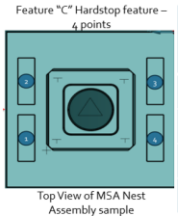
3.1.1 Baseline

Metrologies used by both sites were verified as follows:

Cohu: Mitutoyo Digimatic Indicator (Drop Gauge) with an accuracy of 3 um and within calibration period of 1 year from the time it was checked.
Customer N: Olympus Measuring microscope with an accuracy of 3um and within calibration period of 1 year from the time it was checked.

Baseline was first studied at Cohu site wherein the Drop Gauge measurement was performed by 3 operators on 5 samples. Each operator did 3 trials per sample. A total of 45 readings were included in the study. Before it was moved to Customer N for the same process and number of reading but using the measuring microscope.

Fig. 9 GR&R result on Cohu and Customer N current method using Drop Gauge.



Baseline Data	Cohu Drop Gauge	Customer N Scope
C1	78%	97%
C2	63%	95%
C3	63%	85%
C4	68%	78%

Results showed that the current Cohu and Customer N method are both not repeatable and reproducible. Moreover, the equipment variation has made a high contribution compared to the appraiser variation for both, this excluding part variation.

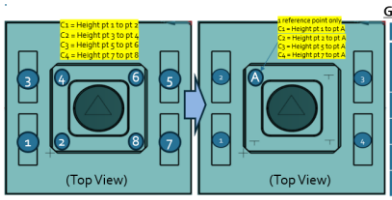
3.1.2 Stabilization

The team checked the gaps on equipment variations related to method, fixture used that contributed to the variation that failed the GR&R result.

There are several methods that were checked: (1) the measurement points, (2) current fixture and the set-up of parts when it is being measured, and (3) design of the parts and its effect when measured.

Measurement points – there are 4 different reference points that are used on the plunger tip surface feature or on the top of the MSA nest assembly surface. The team changed this reference point from 4 different points to 1 reference point only.

Fig.10 GR&R result after implementing the change on measurement points from 4 points to 1 reference point only. The results showed a slight improvement but both sites still failed.



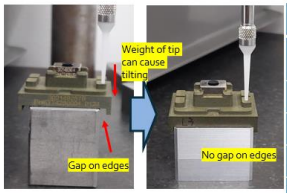
GRR Comparison: Target <30%

Phase	Baseline Data		Change -1	
Feature	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge	Customer N Scope
C1	78%	97%	54%	83%
C2	63%	95%	39%	82%
C3	63%	85%	40%	78%
C4	68%	78%	46%	70%

Legend
Change -1 : Changed the measurement point for reference height on tip of MSA sample surface from 4 points to 1 point only

Measurement fixture – current fixture used were blocks where the parts are placed during measurement. Cohu used a fabricated 1pc square block that the parts can sit while Customer N used 2pc slip gauge blocks. Upon checking the stability of the part when placed on the existing fixture, there are observed movements and tilting of parts when measured, especially when using the drop gauge as there are gaps on edge of the block to the part that was placed which are affected with the weight of the Drop Gauge tip when pointed.

Fig.11 Less Standard deviation when changing the fixture block. GR&R results after implementing the change on fixture or block where the parts are placed when measured. The results showed improvement also but still failed based on criteria.



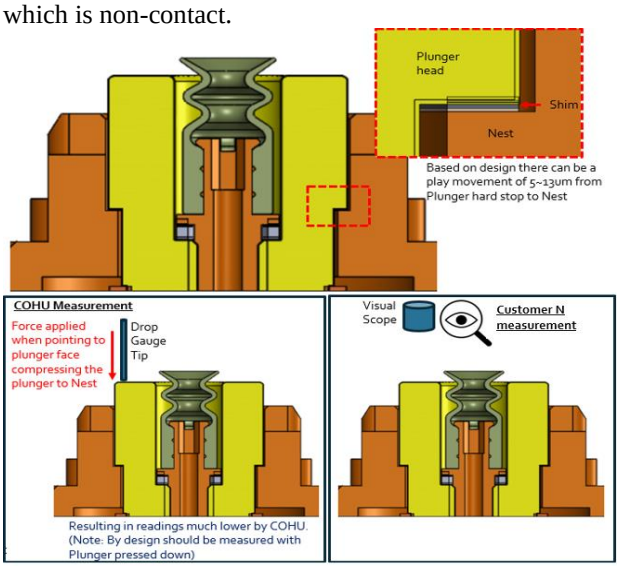
GRR Comparison: Target <30%

Phase	Baseline Data		Change -1		Change -2
Feature	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge
C1	78%	97%	54%	83%	38%
C2	63%	95%	39%	82%	24%
C3	63%	85%	40%	78%	34%
C4	68%	78%	46%	70%	31%

Legend:
Change -1 : Changed the measurement point for reference height on tip of MSA sample surface from 4 points to 1 point only
Change -2 : Changed the fixture or block where the parts are placed when measured to eliminate gaps and avoid tilting

Design effect when measured – Analyzing further the trend of measurement data comparing Customer N and Cohu. Customer N VMM data is always higher than Cohu Drop Gauge. Upon checking, the plunger has shims installed as required by design placed in between the plunger to nest where it will sit. These shims can cause movement and be pressed down when pointed with the drop gauge tip that makes the reading lower than the VMM used by Customer N which is non-contact.

Fig. 12 Visualization on the Nest Assembly design where the shims were installed when plunger is assembled to nest and the effect of pointing the drop gauge tip compared to VMM which is non-contact.



The team overhauled the design of the fixture, and the concept is to compress the sitting of the plunger to the nest even with shims during measurement. The sample of the new fixture was fabricated and evaluated also on GR&R.

Fig.13 Fixture with latch design that will compress the plunger face portion to the nest even with shims. The latch is spring loaded design for a more stable, strong, and reliable compression.

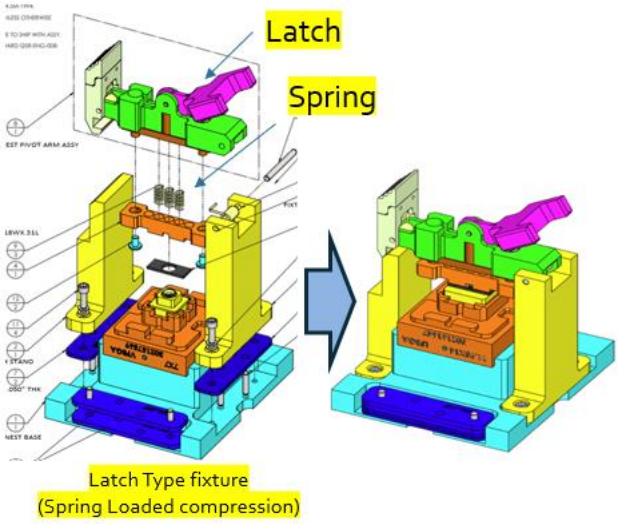


Fig. 14 GR&R results after implementing the change by using the latch fixture. The results in Cohu have already passed.

GRR Comparison: Target <30%

Phase	Baseline Data		Change -1		Change -2	Change -3
Feature	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge	Cohu Drop Gauge
C1	78%	97%	54%	83%	38%	10%
C2	63%	95%	39%	82%	24%	13%
C3	63%	85%	40%	78%	34%	9%
C4	68%	78%	46%	70%	31%	10%

Legend:
Change -1 : Changed the measurement point for reference height on tip of MSA sample surface from 4 points to 1 point only
Change -2 : Changed the fixture or block where the parts are placed when measured to eliminate gaps and avoid tilting
Change -3: Changed the overall fixture from block only to a latch type

Methodology including the fixture that passed the study in Cohu was shipped also to Customer N for the same trial. This includes the measurement point change that improves the GR&R and the metrology which is the drop gauge.

Fig. 15 GR&R results after implementing the change in Cohu method applied to Customer N including the drop gauge. The results for Customer N have already passed also.

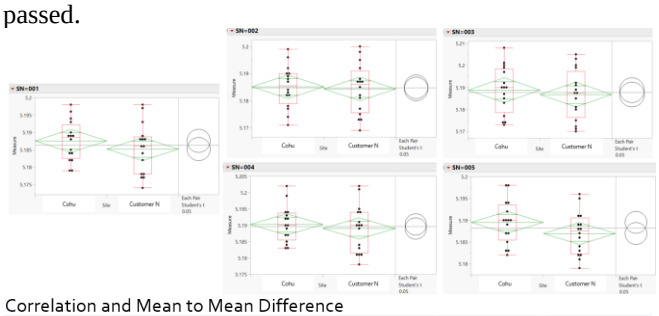
GRR Comparison: Target <30%

Phase	Baseline Data		Change -1		Change -2	Change -3	
Feature	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge	Customer N Scope	Cohu Drop Gauge	Customer N Scope	NXP Drop Gauge
C1	78%	97%	54%	83%	38%	10%	12%
C2	63%	95%	39%	82%	24%	13%	12%
C3	63%	85%	40%	78%	34%	9%	9%
C4	68%	78%	46%	70%	31%	10%	10%

Legend:
Change -1 : Changed the measurement point for reference height on tip of MSA sample surface from 4 points to 1 point only
Change -2 : Changed the fixture or block where the parts are placed when measured to eliminate gaps and avoid tilting
Change -3: Changed the overall fixture from block only to a latch type

Correlation checked had been conducted and results are also passing when using the same fixture and methodology even using actual nest assembly parts.

Fig. 16 Using JMP One way analysis and using Each pair Student t-Test comparing Customer N and Cohu measurement when both implemented the same latch type fixture and methodology including drop gauge. The result passed.



Correlation and Mean to Mean Difference

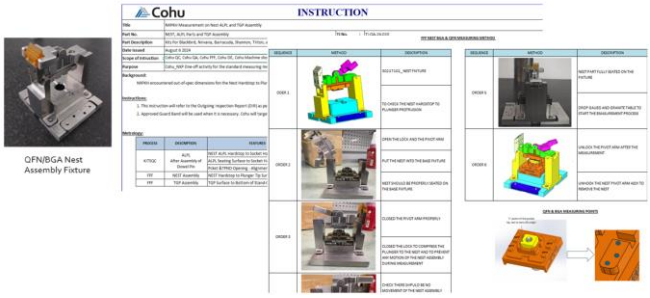
	SN01	SN02	SN03	SN04	SN05
Correlation pValue <0.05	0.3124	0.7897	0.6117	0.5851	0.1519
Mean Diff	2um	1um	2um	1um	3um

3.1.3 Alignment

After passing both the GR&R and correlation study by using the Latch type fixture, common measurement points and metrology which is drop gauge. Below were aligned between the two sites:

(1) Cohu fabricated another set of Latch type fixture for Customer N use.
(2) Customer N also purchased Drop Gauge.
(3) Measurement points were aligned.
(4) Cohu released documented instruction internally and to Customer N for standardization that indicates the full methodology that was followed.

Fig. 17 Actual Fixture used by Customer N and Cohu and the released documentation for the guidance of both sites.



This aligned methodology was used on the following orders shipped by Cohu to Customer N. A total of two (2) orders were verified prior shipping to Customer N and results were already aligned for both factories eliminating production delays, back and forth returning of parts for remeasurements, cost of shipping, rework and labor cost that is beneficial to both factories.

5.0 CONCLUSION

Differences on the measurement between two sites together with the non-repeatable, reproducible, and correlated methodologies impacted the differences on judgement when measuring parts.

With the various methodologies evaluated, the methodology that correlated and with passing GR&R had been defined by both sites using a drop gauge in measuring height dimension of nest assembly including a common measurement points and fixture for stabilizing the part during measurement.

Subsequent orders of Nest Assembly batches were measured using the aligned method and successfully passed 100% on both sites' inspections thus eliminating production delays, back and forth returning of parts for remeasurements, cost of shipping, rework and labor cost.

6.0 RECOMMENDATIONS

Though the methodology defined using drop gauge with common measurement points and fixture did not fail the GR&R the condition still needs to be lowered down by further enhancing operator variations through detailed instruction and part variation through improvement at fabrication process.

In terms of the correlation, the scope of this project focuses on a specific part, feature and customer. Standardization and learnings on this study can be considered across all parts and customers to prevent other issues moving forward.

7.0 ACKNOWLEDGMENT

The authors would like to appreciate and acknowledge the support of the Cohu inspection group and our customer on the cooperation and collaborative effort to accomplish all measurements needed for the study. A warm gratitude also to Mr. Johnny Blas and Mr. Don Grant for guiding the team through this study.

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9.0 ABOUT THE AUTHORS

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Association of Semiconductor and Electronics Manufacturing Engineers of the Philippines (ASEMEP)

34th ASEMEP NATIONAL TECHNICAL SYMPOSIUM

"Innovating for a Sustainable Future: Excellence in Semiconductor and Electronics Manufacturing Solutions in the Age of AI and Industry 4.0"

20th Philippine Semiconductor and Electronics Convention and Exhibition (PSECE)

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34th ANTS 2025 AUTHOR'S CHECKLIST

This checklist is intended to assist the author(s) in the preparation of technical papers for review by the ANTS 2025 Technical Screening Committee.

Technical Papers are due on **JUNE 2, 2025** and the requirements are:

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I verify that I checked all of the above-listed requirements.
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