

BAYFLEX SOLUTIONS

Developing Lab Automation & Data Analytics for Flexible Electronics

Reliability Analytics: Trends & Opportunities In Flexible Electronics

February 2023

Eisuke Tsuyuzaki
bayflextechnologies.com



**Reliability &
Performance:**

**You can not improve;
what you can not measure
by repetition & feedback**



Current Environment

New Designs with Rigid Components + Flexible Substrates

Technical (More and Complex)

- Ensure Integrity of New Materials & Micro Electronics in Continuous Use (cracks, contact failures)
- Detect Micro Strain fractures of New Materials (delamination, deformation)
- Continuous Testing in Complex Hostile Conditions (flex, elongation, torsion etc. temperature, humidity)



Business (More with Less)

- Efficiently deliver products for emerging growth markets e.g. Flexible Displays, Mobility, Medical etc.
- Secure/maintain Skilled Workforce e.g. Lab Techs, Chemists, Engineers, Data Scientists
- Expand Sustainable Business Practices
- Business Productivity has evolved to take advantages of major technology advancements e.g. PC, Internet and Mobile... Cloud? AI?

Failure Modes & Mechanical Motions

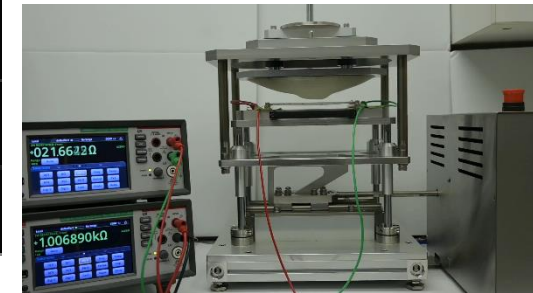
REPEAT

Deformations	Fold	Flex	Twist	Roll	Stretch	Bend
Cracked	possible	possible	YES	YES	YES	YES
Delaminated	YES	YES	YES	Possible	possible	possible
Bent Permanently	YES	YES		YES		possible
Stretched Permanently			possible		YES	possible
Torn			YES		possible	

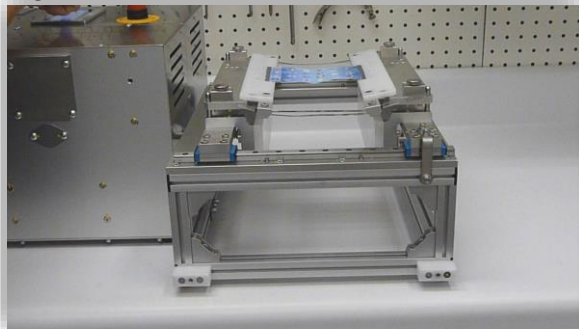
BEND



PUSH



FOLD



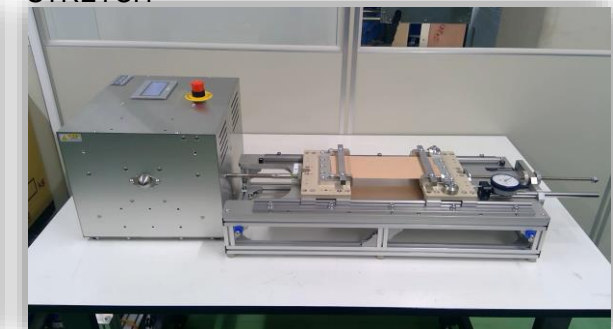
FLEX



TWIST



STRETCH



State of the Market

Magnitude of Mechatronics Efficiency is Multiplication (Speed, Capacity, Movement refinement)

Delivered 1,100 Mechatronics Systems to enable

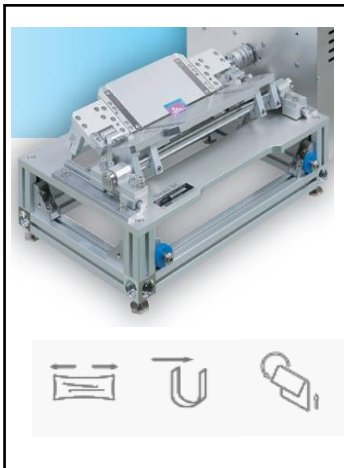
→ Testing Processes & Methodologies for Standardization / Common Practices

Situation: 90% of Lab time used to refine Home built tools; only 10% for Data Analysis

→ Test Coupon Samples sent by Delivery Courier with “Trust Me” note

1

Mechanical Testers



REPEAT

2

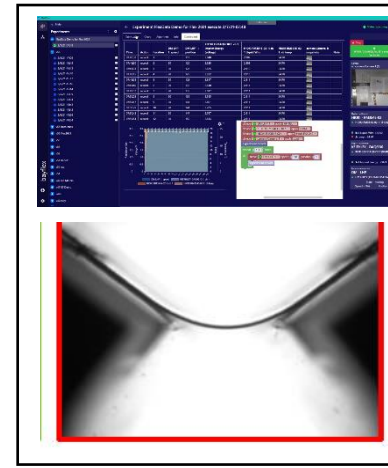
Motor Drive Unit



MEASURE

3

Lab Automation & AI analytics

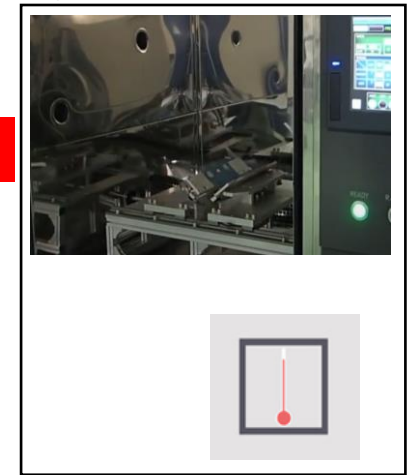


OBSERVE



4

Hostile Systems

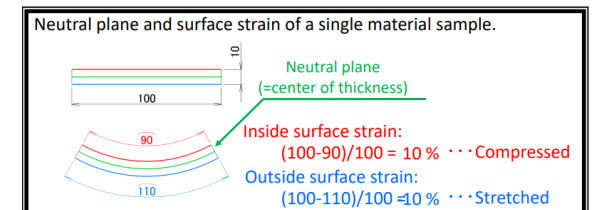
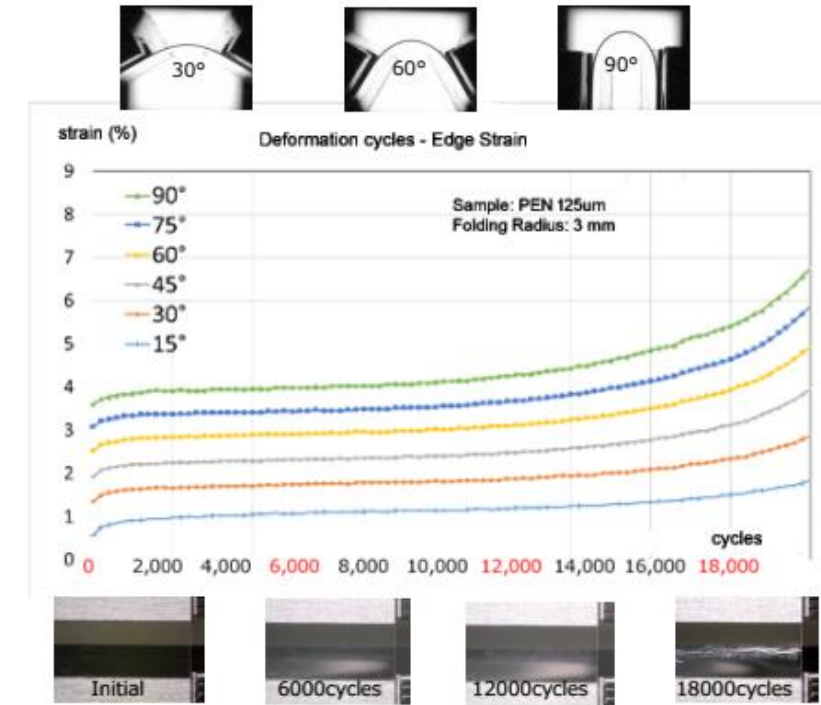
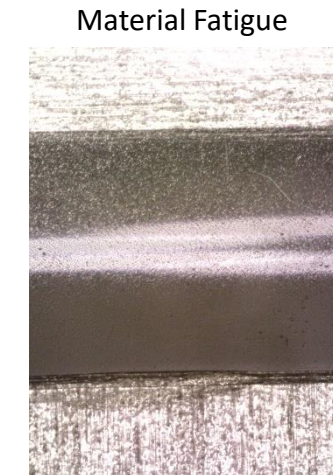


Need for Better Data Transition

Opportunities of Data Efficiency is Exponential (Predictive, Scale to Manufacture, Product Lifecycle)

- Optical Imaging used for Inspection, Analysis and Prediction (image recognition and data computation)
- Expanding Universe of Data Harvesting (resistance, torque, load cell, temperature, humidity ...)
- Monitoring/Control of Application specific devices, Environmental Chambers for Adv. Lab Automation
- One Reliability Constant for R&D, QA Qualification, Manufacturing, End-Device Monitoring

Note:
Uncompressed Continuous Image for 200K cycles @ 75TB
> whereas most laptop SSD capacity is 1-2 TB
> Cloud first architecture is mandatory



Reliability Performance Benchmarks by Industry



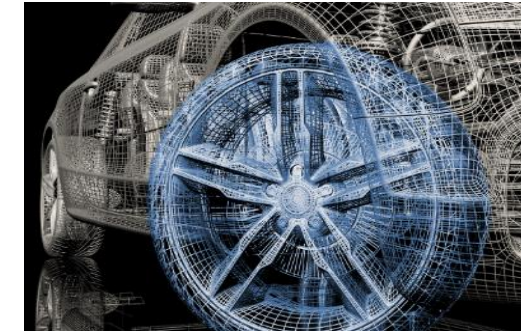
Flexible Display / MetaVerse / Wearable Applications

- Multiple layer Testing for Delamination / Deformation with Optical Imaging for Realistic Product / Human Movements, in Hostile Environments measuring Resistance, Torque etc.
- Established Consumer Electronics standards over 1 mil cycles, 200K component level



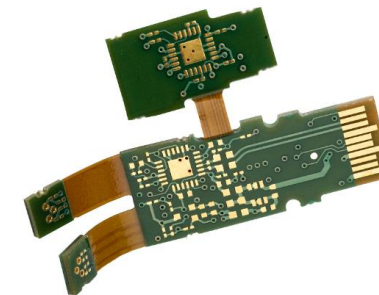
Mobility / In-Mold Applications / Aviation

- Thin-layer Testing for Functionality (resistance / temperature) with some Optical / CT Imaging in Extreme Environments & Accelerated assessments (UV) measuring Multiple Resistance, Load Cell etc.
- Established Automobile standards over 1-2 mil cycles, in hostile / extreme environments



Medical / E-Textile Applications

- Thin-layer Testing for Functionality (resistance, impedance, temperature) with some Optical / Infra red Imaging for Human Movement in Multi-Climate Environment (liquids, altitude) measuring Mico-electronics functionality
- Evolving standards; thousands to 50K cycles, eventually in hostile environments

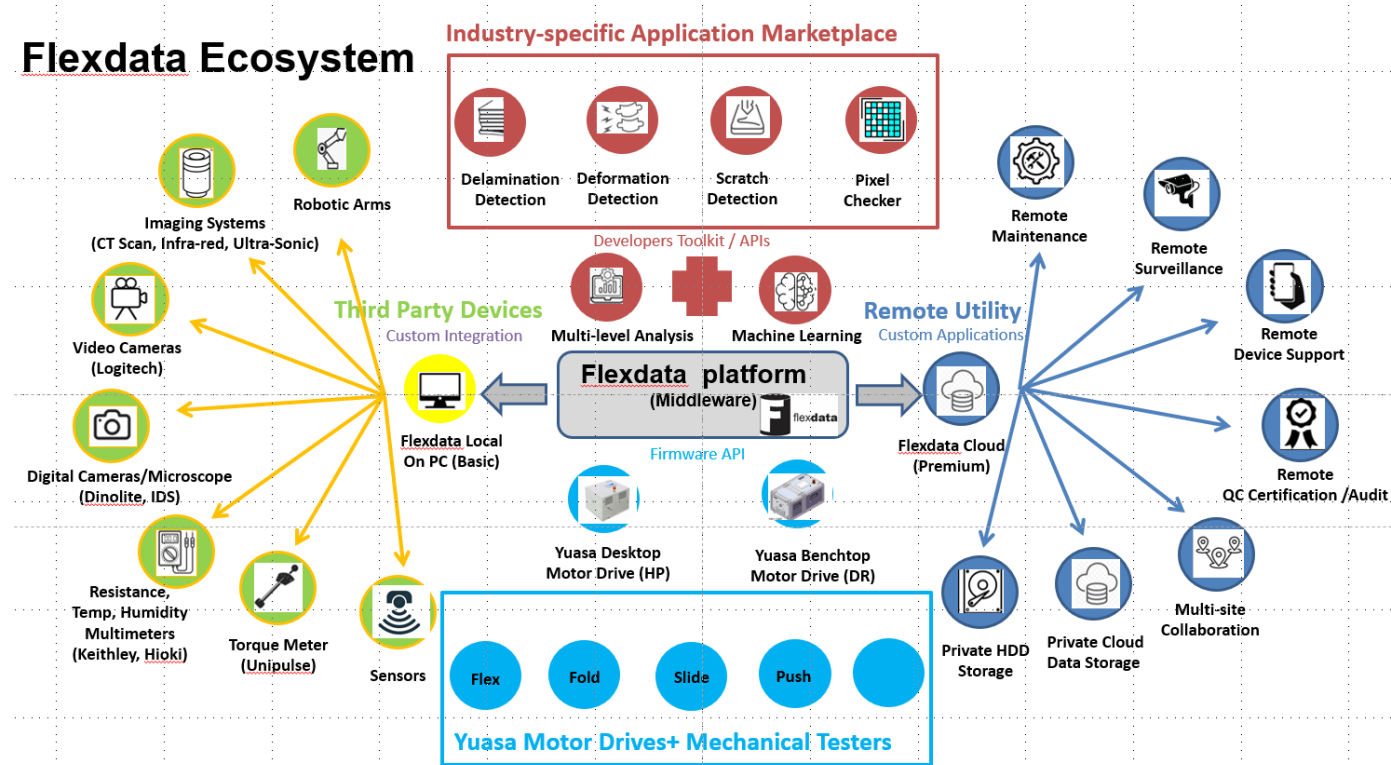


Our Flexdata Philosophy



Core Elements

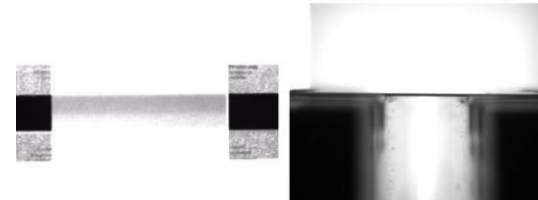
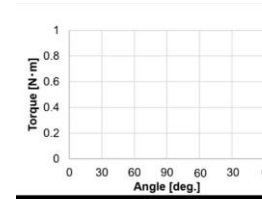
- Disclosure
Published Technical Approach & Architecture
- Independent
Designed in Third Party Device Integration
- Low Barrier
Cloud Architecture, Provided or Client Cloud for Collaborative development/Supply Chain
- Accessible
Easy of Use/Re-Use for Complex assessments, Remote surveillance/operation
- Client-led Development
Major N.America/Europe Companies/Institutes



Flexdata Foundation & Extendibility

Lab Automation and R&D

- Easy-Set Up and Complex System Control
- Lab test development
- Manufacturing data analysis
- Field data analysis
- Dataset development & preparation
- Classification, Anomaly Detection, Prediction Models
- Performance analysis



YUASA
YUASA SYSTEM CO., LTD.

Factory Automation



Manufacturing QA

- Manufacturing Testing, Anomaly Detection
- Product classification
- Data collection



Field Operations

- Data collection
- Predictive maintenance
- Anomaly detection
- Performance analysis

Flexdata test drive



System Control & Analytics Platform New for 2023 (2Q availability)

SmartStop

Preset/Monitor Data Measurements
Resistance, Load Cell, Torque, Temp
Text Alert to Lab Technician

ActionReplay

Fast Image Compiler

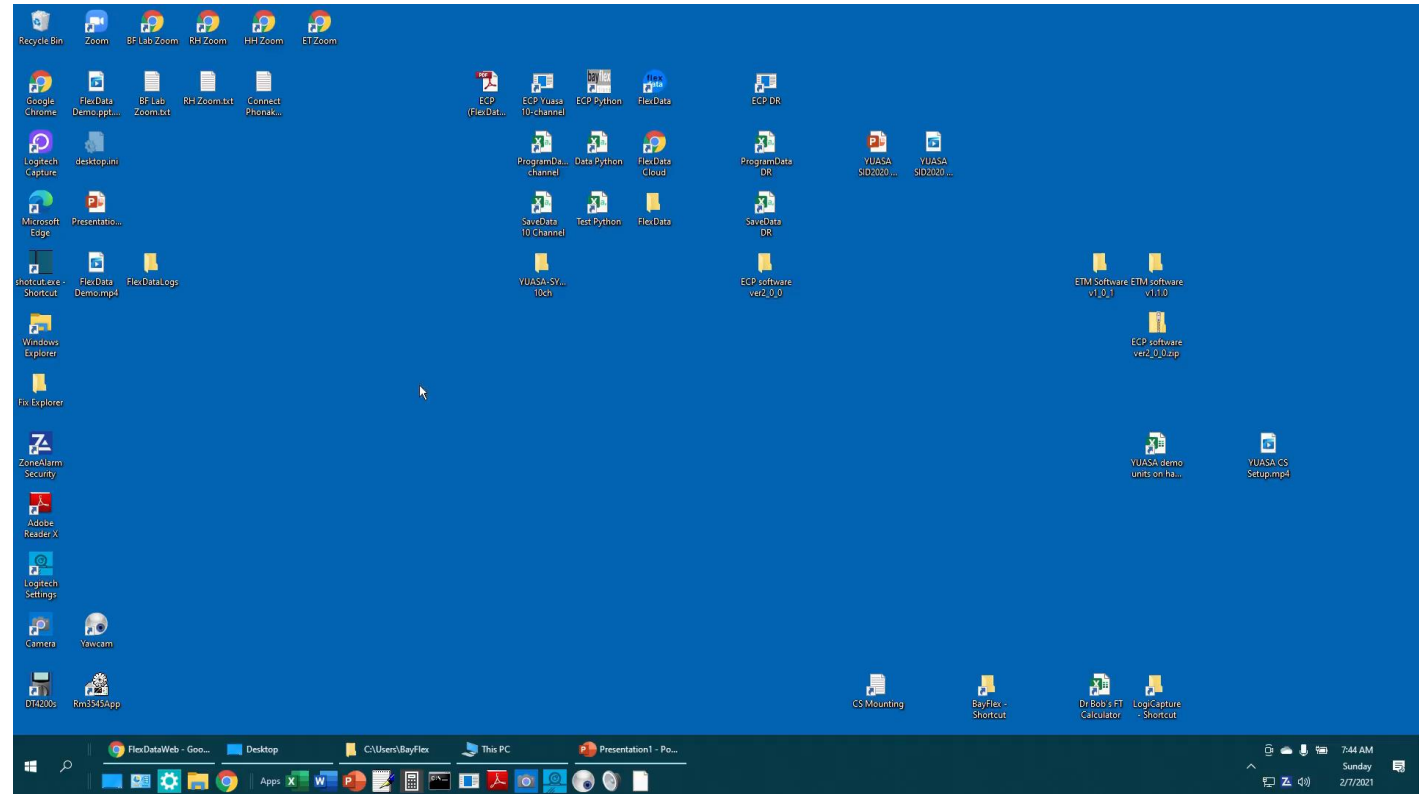
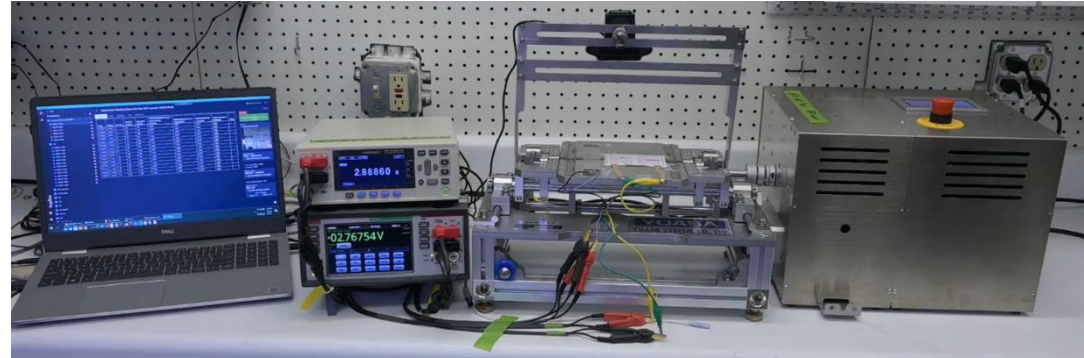
Enhanced Visualization

Add existing Matlab Libraries

Third party device on/off automation

Already available

- Easy set up and system control
- Web and Dinolite optical integration
- Hostile environment integration
- Cloud first foundation
- Multi-language support



Looking Ahead

Data Visualization:

More Data, More Images ...

How to present information to make a better decision faster –

Seek Data Relationships

(both Known & Unseen)

Data Types

- Category
- Ordinal
- Discrete
- Continuous

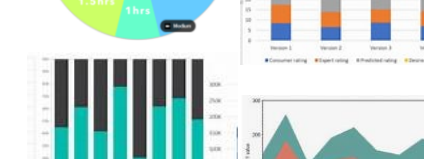
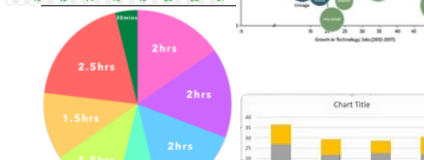
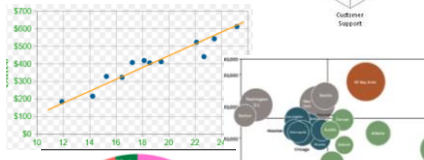
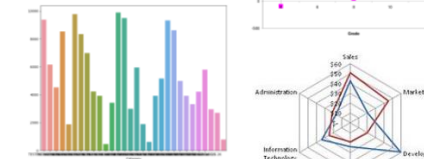
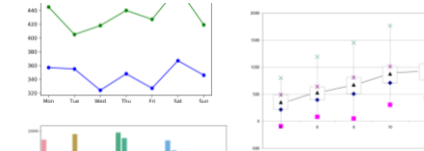
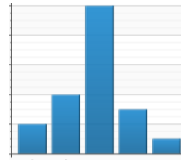
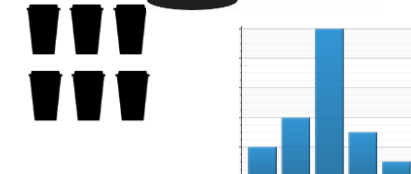
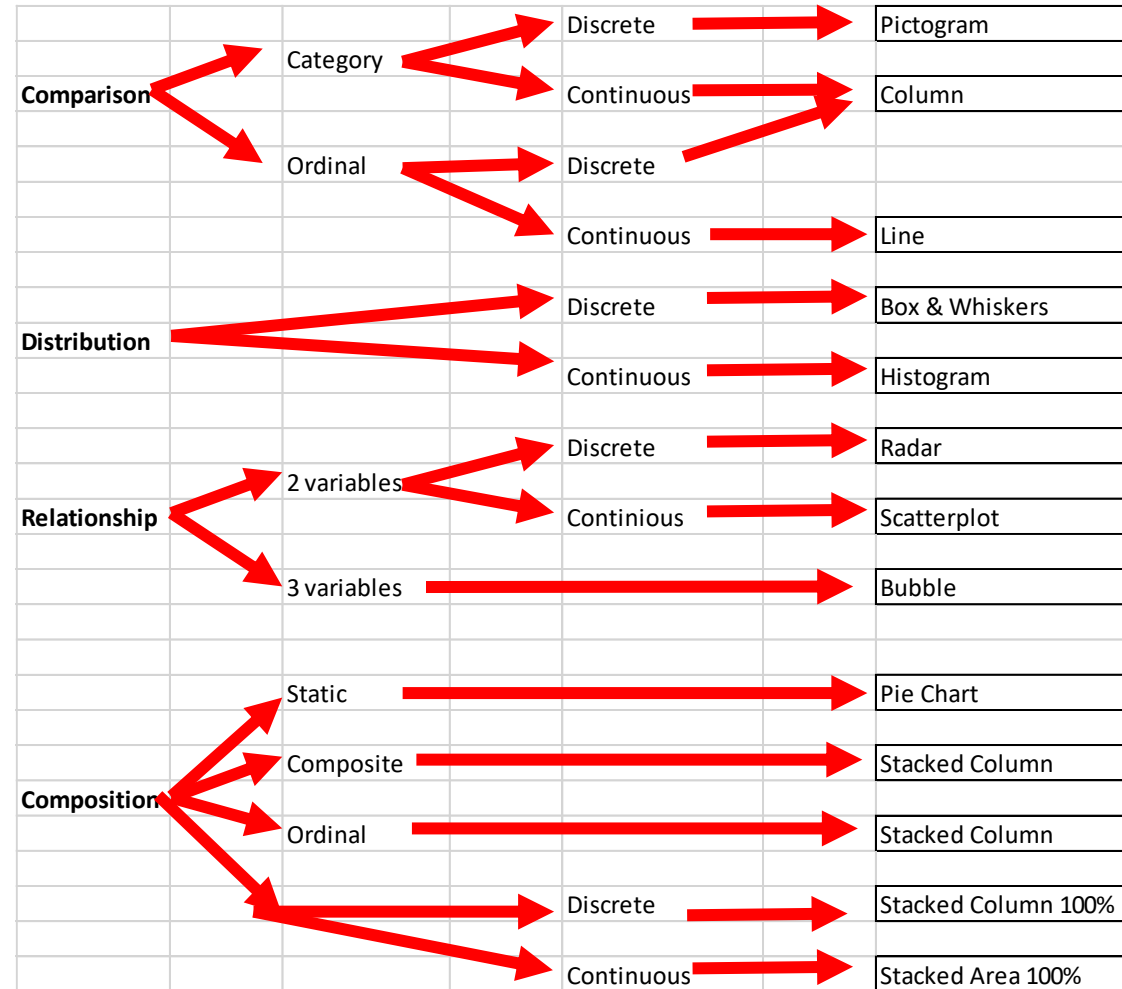
Presentation Types

- Colour
- Hues
- Shapes
- Width
- Heat Maps etc.

➔ Collect only Useful Data

➔ Use appropriate Analytical Tools

➔ Integrate libraries e.g. Matplotlib



More images

Looking Ahead..contd.

Data Scrubbing

Store & Improve accuracy of data

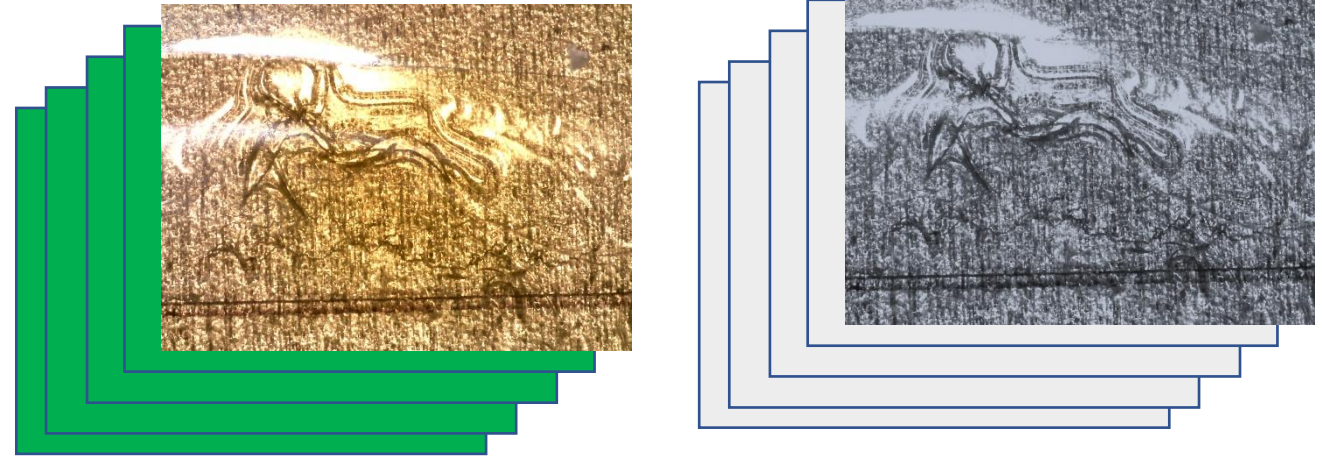
- Parsing Identifies data
- Correction Fixes data
- Standard Adheres to format/rules
- Matching Eliminates duplication
- Consolidate Combines data sets

→ Visualization + Data Scrubbing =
Machine Learning

→ Seek data relationship (rules based)
patterns for Unique predictive analysis

Visual Recognition

Compare Good/Fail images



Microbubble Images (Delamination)

→ Input = Yes, No, Maybe =
Visual Recognition (requires many samples)

→ Seek data relationship (unsupervised)
patterns for Unique predictive analysis

Combination of rules based and unsupervised pattern recognition
leads to generative Artificial intelligence

Data Performance Preparedness

Which level is your organization?

- Level D0 Denial – No Data / Don't Know
- Level D1 Human level – Pen & Paper
- Level D2 PC level – Excel, Macro (No Images)
- Level D3 Specialist level – Matlab, C++, etc. & Manufacture specific applications
- Level D4 Cloud Architecture
– Integrated Data / Image Framework
- Level D5 Advanced Cloud
– ML / AI enabled Data Modelling
incl. Digital Twins (optimize feedback)



Business Reward



Flexdata as your co-pilot in Flexible electronics Reliability improvement

- Fractional / Scalable Investment to streamline/augment existing Engineers

- Mechanical Engineer Time \$130K @ 15% time = \$20K / Yr.
- Lab Tech \$52K @ 70% time = \$36K / Yr.
- Matlab Software Engineer \$ 250K @ 30% time = \$80K / Yr.
- Data Scientist \$80-180K = \$130K / Yr.

→ Better Human Capital Deployment / Higher Retention /
Augment Multi-skills for Technicians / Lack of Data Scientists

→ Decrease Courier/Shipping Costs of Samples – with secure Audited data
More specific feedback communication with Supply Chain

→ Higher productivity with Multi-level, Multi-site Analytics & Advanced applications
Lab instrumentation Approach proven in Pharma & Clinical development

→ Incalculable Opportunity Profit/Loss with Speed to Market



Seeking Groundbreakers



Take Action - Become better Prepared;

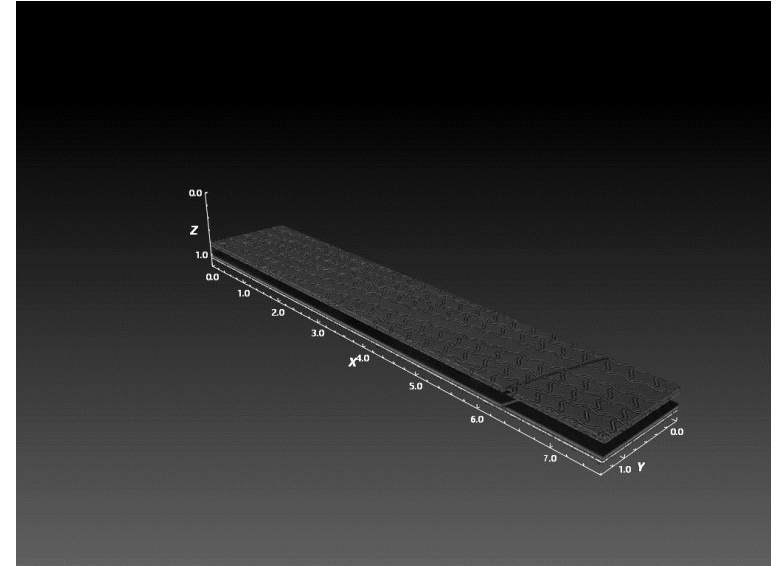
- Recognize the importance of Data
- Confirm Company Data Policy
- Establish Data Targets for specific products
- Get involved with Staff training

Expand the Wheel - Open to Collaboration with;

- Device Manufacturers (Meters, Robotics, Flying Probe, R2R)
New Accessory Integration thru GPIB/USB interface, Feedback to Manufacturing Systems
- Application / Product (Visualization, Testing Assessments)
Matlib Integration, Connections to existing Material Databases
- Start-ups solving critical scaling issues
Seed investments thru Bayflex Technologies

Gratitude amplified;

- All our Clients and Friends
- Collaborative Partners
- Strategic Partners (Yuasa System, American Semiconductor)
- Bob Hopkins, Wolfgang Mildner and Leonard Sheiba

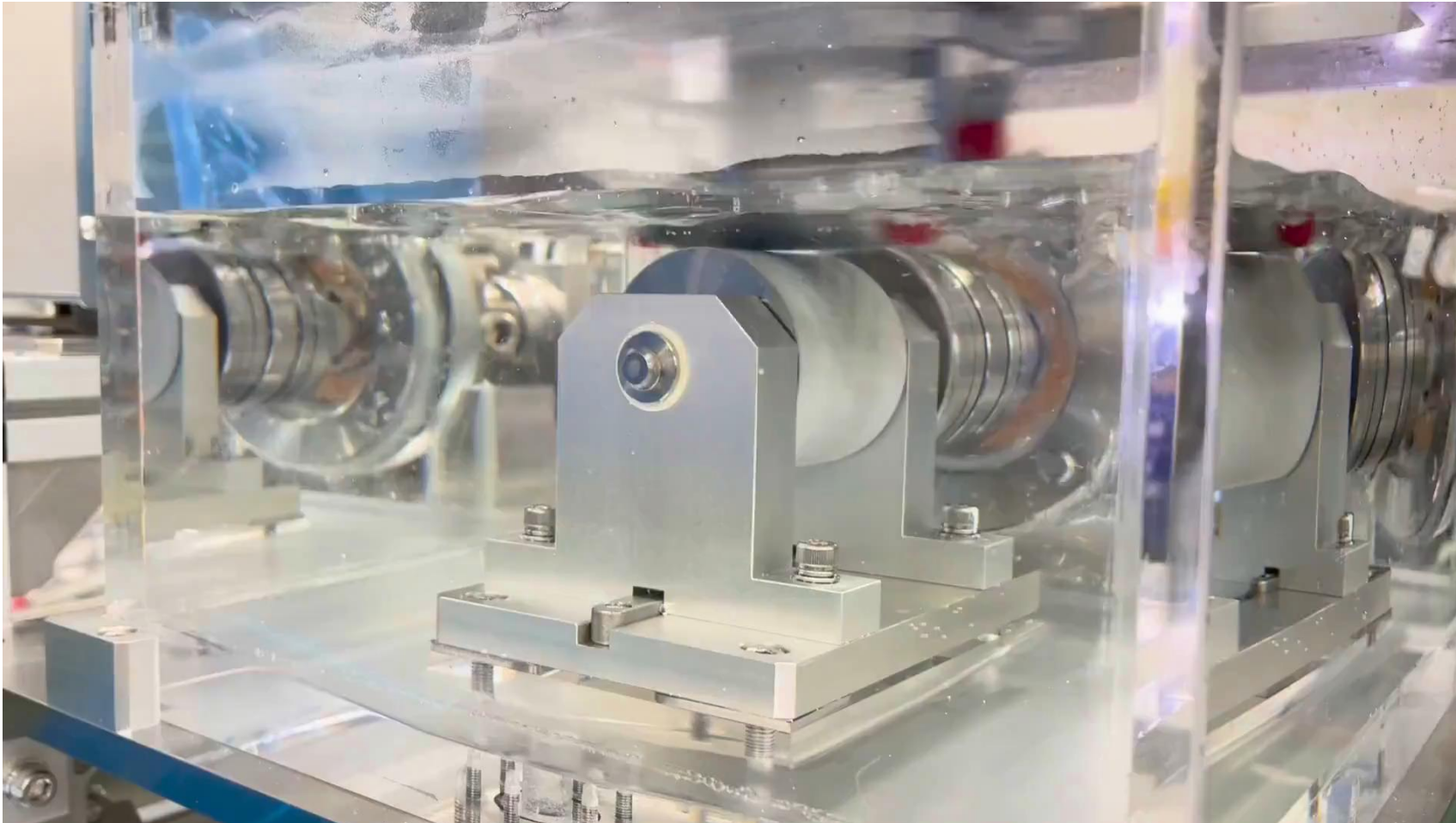


Multi layer Delamination concept (w Early Charm Ventures)



.. and one more thing

bayflex
solutions



PICO
multi-climate integrator

When you think of reliability...



www.bayflextechnologies.com



B0.109



etsuyuzaki@bayflextechnologies.com



[#bayflexsolutions](https://www.linkedin.com/company/bayflex-solutions)



[bayflex testing](https://www.youtube.com/watch?v=bayflex_testing)