

BAYFLEX SOLUTIONS

Bridging the Reliability Chasm: Applying AI driven forensics to Qualify Electronics for Military and Space Environments

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Modern Electronics Challenge

Rapid adoption of Commercial Off-the-Shelf components and Flexible Hybrid Electronics in defense and aerospace
e.g. origins from CE, Wearables, Auto

However, traditional military specification hardening cycles do not necessary synchronize well with consumer electronics innovation cycles

AI = Need to do more with Less.
Realization of Systems require AI for Edge Devices;
can be seen in Material Formulation;
and early efforts in automated Design Layouts

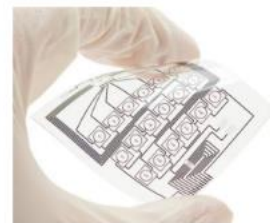
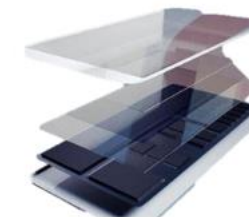
AI can also provide forensic-grade capability for mass reliability for experimental & non-hermetic designs

Smartphones Components

Sensors
Display Devices
Processing
Antennas
Power

Technology Cores

Wearables
Robotics
Implants
Energy Harvesting
Communication
Drones
Munitions

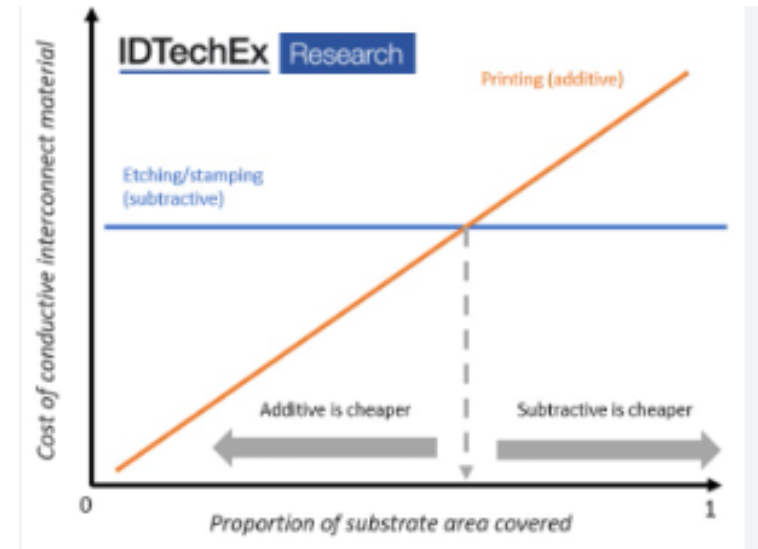


Reliability Chasm

Flexible Hybrid Electronics is moving from R&D prototypes to trusted higher volume production > **reliability & yield key to scale**

However, Traditional testing do not emphasize Reliability Data to determine trend analysis; where FHE materials performance may degrade over time unlike rigid PCBs

Hereto, FHE qualification processes has been able to better detect **mico-fissures and delamination before catastrophic field failure**
 n.b. Largest FHE application is in Display Devices



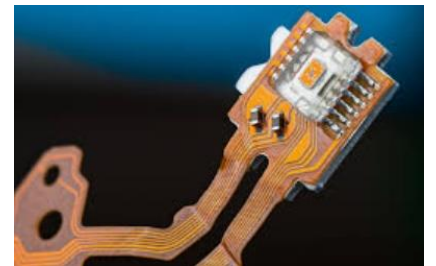
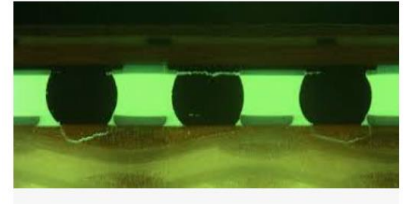
Relevance of FHE processes

Flexible Electronics failures are “progressive” and “invisible,” meaning that the Industry could not just rely on discrete Pass/Fail thresholds

Root cause analysis requires to determine Mechanical Stress Integrity with Electrical Performance and Environmental Conditions mandating a “multi-modal” data approach

FHE manufacturing scale (yield + reliability) is growing up in “Big Data” Frameworks which naturally favors a transition to Predictive Forensics leveraging AI technologies

Combined, these advancements can improve reliability in Solder Joint Fatigue (micro-cracks) in Ball Grid Arrays due to heat expansion; Qualifying connectors with flexible components; and Non-Hermetic Components (such as real time detection of mechanical stress in humid / moist conditions)



Cautionary AI activities to date

95% of early Corporate AI projects have failed

While useful for Individual basic productivity & simple reserach
With Large Language Models (LLMs, e.g. ChatGPT, Claude)

Generic LLMs cannot access proprietary information

(e.g. Domain Expertise) Enterprise Training, Private Defacto Standards, Intellectual Property

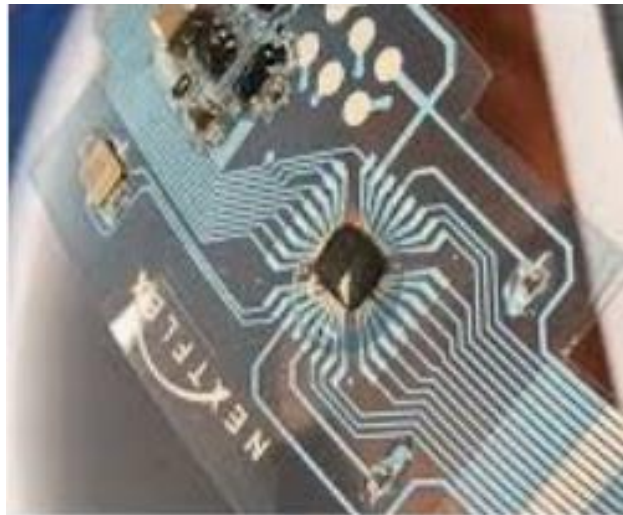
Individual / Team datasets usually not linked to Corporate data bases, Materials Data bases, Hampers Formulations, Difficult to build failure prediction models



Cross Industry Initiatives

NextFlex is a US Govt public private partnership focused on FHE manufacturing. Partnered with Dept. of War Defense-led Manufacturing Institute to advance MRL 7

Organic & Printed Electronics Association is the largest FHE community, initiatives focused on technology processes, education and market development including driving IEC standards



About Bayflex Solutions



From Silicon Valley, we provide a “reliability stack” for flexible materials, components & devices (Hardware, Software, Services, Consulting)

Develops lab automation and data analytics optimized for Printed Display & Electronics markets since 2015. in Healthcare, Automotive, Military, Industry (Member of OE-A, SID, NextFlex, SEMI/Flextech, IPC, HAND)

1

Mechanical Testers



Interchangeable Mechanical Testers

REPEAT

2

Motor Drive Unit



Interchangeable Rotary + Linear Motion

MEASURE

3

Lab Automation & AI analytics



Flexdata platform



OBSERVE

4

Hostile Systems



Environmental Chamber & Multi-climate integration (liquids, gas, altitude)

Failure Modes & Mechanical Motions

Delivering interchangeable modular systems; many with tension-free mechanisms



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	

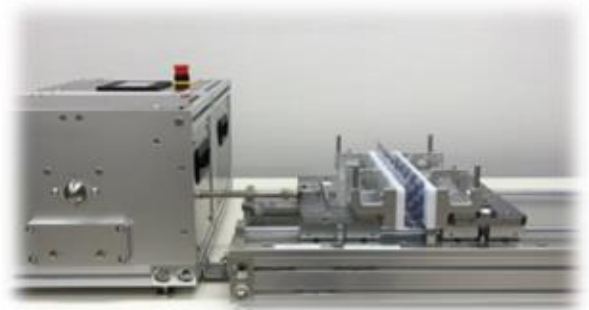
BEND



PUSH



FOLD



FLEX



TWIST



STRETCH



Foundation – Meters, Mechatronics, and Visualization tools



Mechanical Testers

Time Stamp, Cycle Count
Speed, Angle

Instruments & Sensors

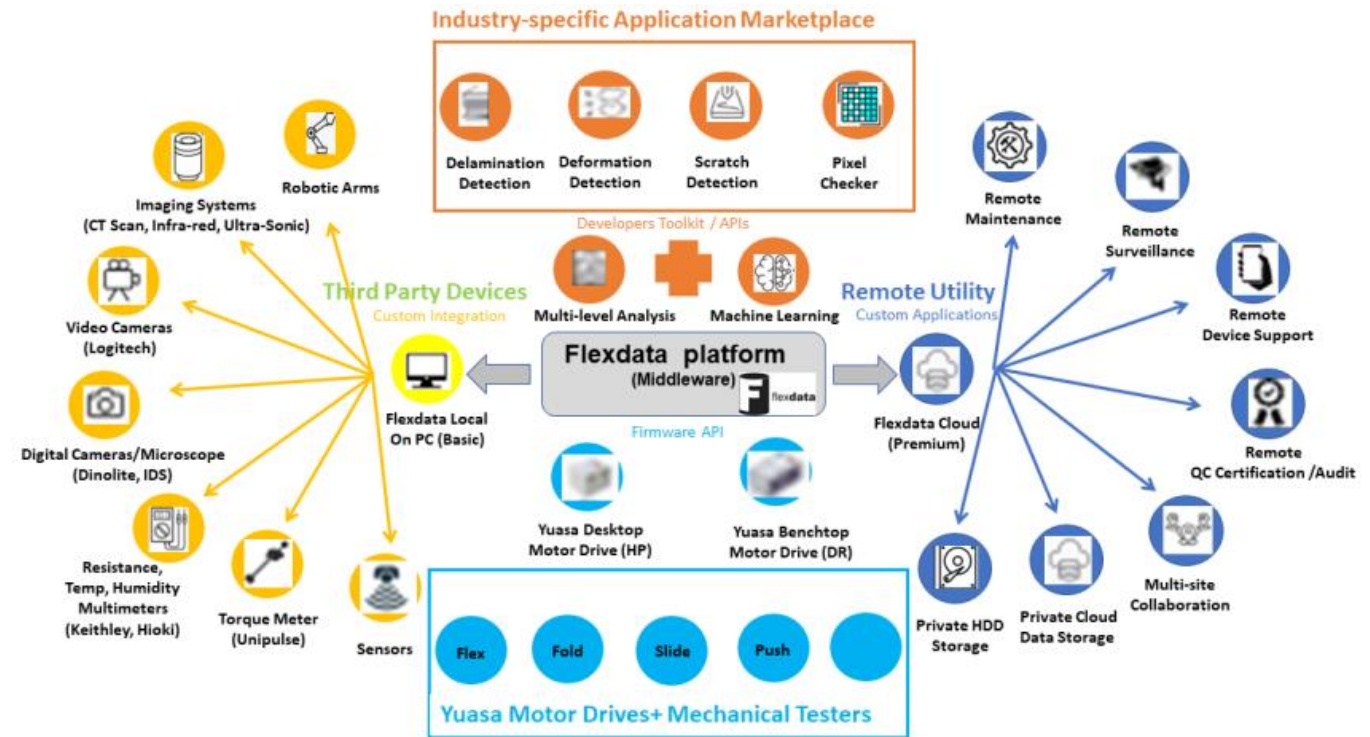
Limitless Resistance Channels (2/4 wire)
Voltage, Capacitance,
Mechanical Torque
Mechanical Force
Temperature, Humidity
RFID, NFC, BLE signal strength*

Other

Imaging Systems (Optical, Infra-Red)
Hostile Chamber monitoring
Robotics* & third-party device synchronization

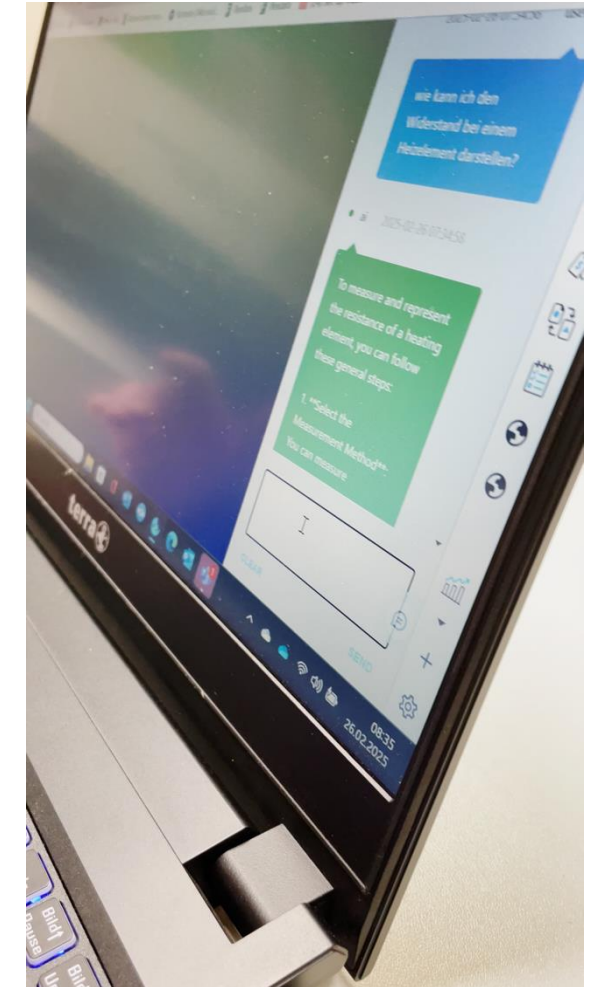
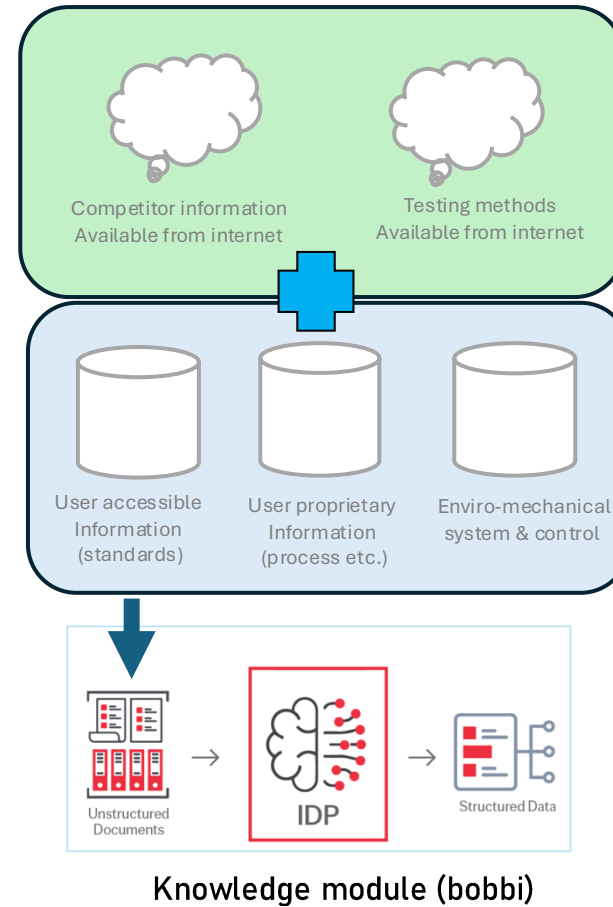
Automation

Easy Test Algorithms & Simple Re-Use
Continuous Measurements
Automatic Data Storage
Remote Surveillance
Predictive Operation
Action Replay rapid Image playback



Custom Software Development – Knowledge module

- **Overall:** 4 years of promising results from LLMs like OpenAI / ChatGPT for controlled information retrieval
- **Purpose:** Store authorized standards, best practices, testing documentation, test recommendation & menus, system command & control
- **AI Integration:** Provides “assistant-like” step-by-step guidance and AI-driven curation of relevant private resources (e.g., training videos, manuals)
 - > OpenAI ChatGPT like Large Language Model.
- **Application Focus:** Customizable material database for evaluating application specific components and performance
- **Results:** Better Human Capital Deployment / Higher Retention. Augment Multi-skills for Technicians / Lack of Data Scientists / Better manage variable material costs



Case Study: Test Operator Assistant (Bobbi)

Dedicated AI LLM tools for Creating Context

Use neural network (relationships) for unsupervised learning

Focused use of AI tied to real-world testing environment

70% Productivity Increase for Test Operators

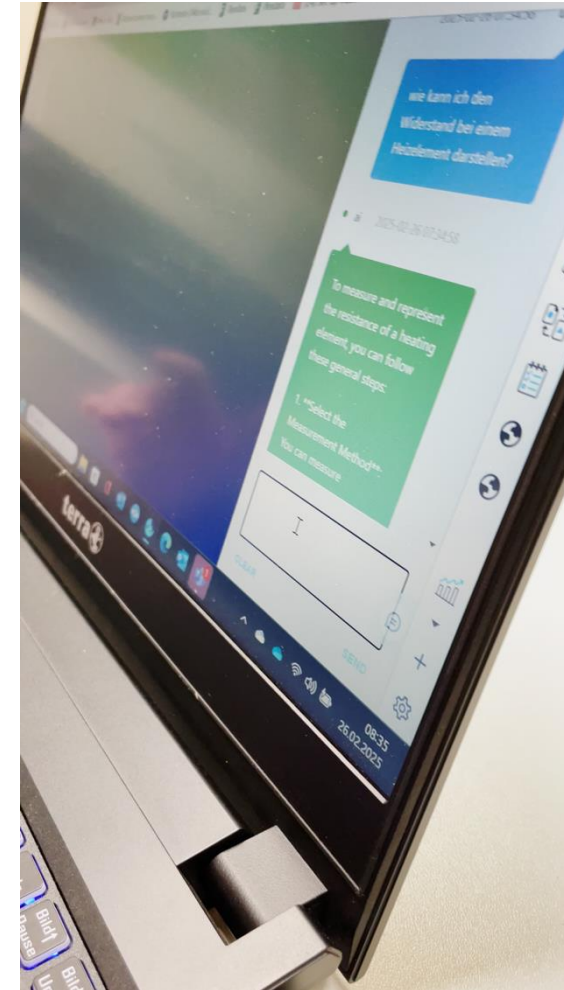
Ask How to test sample for particular application

Researches Proprietary Databases + Open Internet

Responds with choices

Prompts most appropriate test assessments program

Prompts to run automated test coupons



Ask: “How to test Smart textiles”

Chat Agent test FD

+ Properties

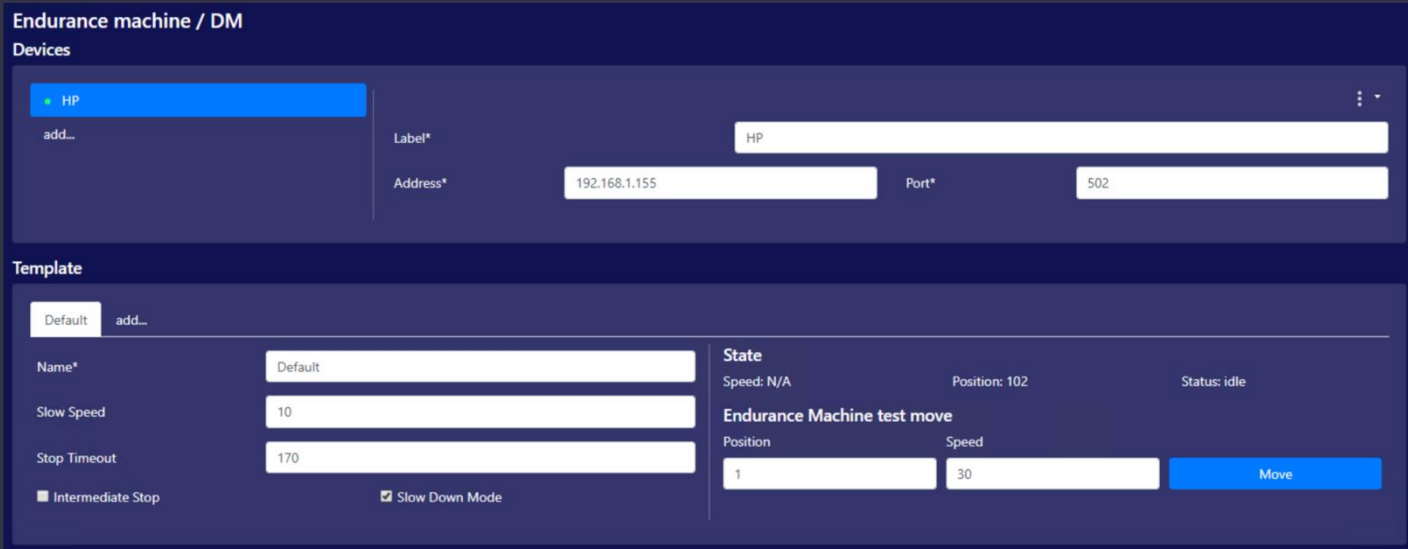
How you will test smart textiles

#5979 Feb 11, 2026, 4:17:28 PM

To test smart textiles using Flexdata algorithms and Yuasa Endurance Test Machines, you can follow these steps:

- 1. Setup the Device and Template:**
 - Begin by configuring the Endurance Machine through Flexdata. Select the appropriate device from the 'Devices' section, enter the device label, its IP address, and the port number, typically 502.
 - In the 'Template' section, set the template name and configure the settings such as 'Slow Speed' and 'Stop Timeout' to control the machine operation. Options like 'Intermediate Stop' and 'Slow Down Mode' can be customized to suit the testing requirements.
- 2. Configure Testing Parameters:**
 - Define the test parameters using Flexdata's algorithm blocks. For example, you can set channels to measure resistance, voltage, temperature, humidity, load, or 4-wire resistance depending on the type of data you want to capture from the smart textiles.
 - Use the DAQ (Data Acquisition) system to measure these parameters by selecting the appropriate channel settings and sensors.
- 3. Run the Experiment:**
 - Use an existing algorithm or create a new one in Flexdata to run the test. Import the algorithm as a .xml file into Flexdata if needed.
 - Specify the motor speed and number of cycles as per your testing requirements. You can use archival ECP files for specifying motor speed and cycles if necessary.
- 4. Monitor and Analyze Data:**
 - During the test, monitor the current state, including speed and position, using the Flexdata interface.
 - Analyze the captured data for insights into the performance and durability of the smart textiles.
- 5. Adjust and Iterate:**
 - Based on initial results, adjust the testing parameters or refine the algorithm to better suit the smart textiles' characteristics.
 - Re-run the tests as needed to ensure comprehensive evaluation.

For visual guidance, the interface for configuring and testing an Endurance Machine with device and template settings can be seen in the image below:



Endurance machine / DM

Devices

Label*	Address*	Port*
HP	192.168.1.155	502

Template

Name* Default

Slow Speed 10

Stop Timeout 170

Intermediate Stop Slow Down Mode

State

Speed: N/A Position: 102 Status: idle

Endurance Machine test move

Position 1 Speed 30 **Move**

Ask: “Test algorithms for Smart textiles”

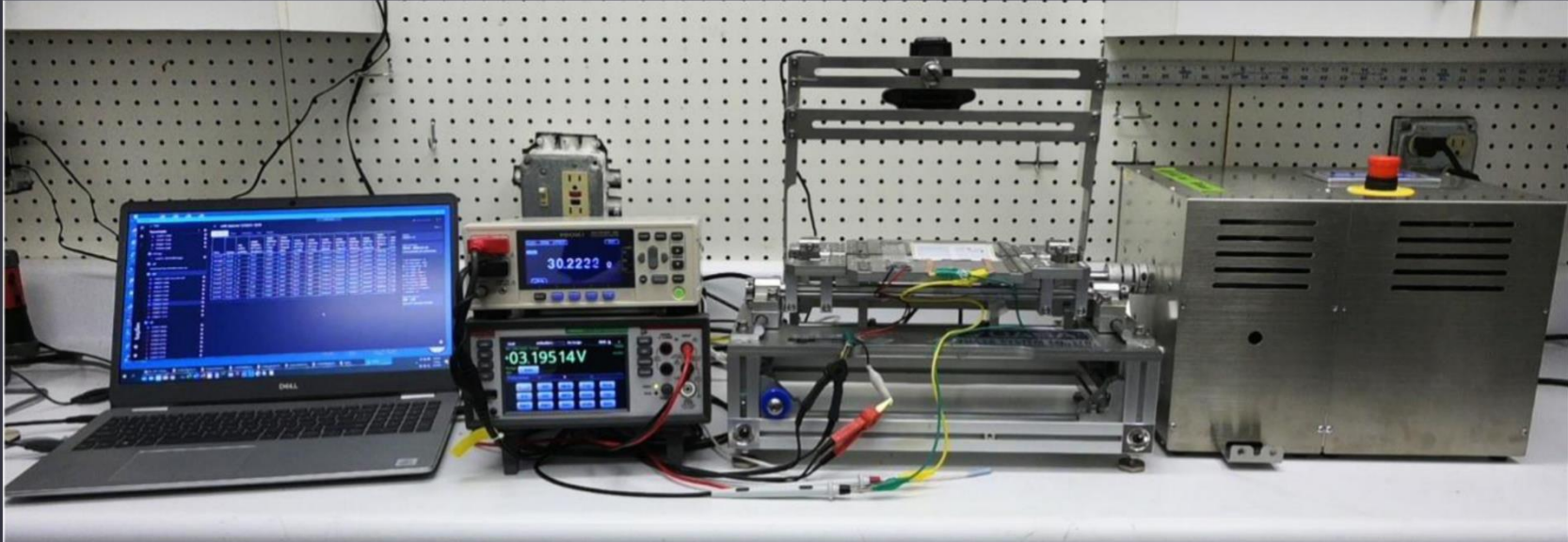
Can you provide examples of algorithms suitable for testing smart textiles?

#5980 Feb 11, 2026, 4:18:06 PM

The document "Flexdata Algorithms" provides examples of algorithms used within the Flexdata system, which can be adapted for testing smart textiles. While it doesn't specifically mention smart textiles, it does describe algorithms that control various test machines and data acquisition devices. Here are some examples that could be relevant:

- 1. Simple Flexdata Algorithms:** These algorithms control devices such as the DR Motor Drive Unit, the Keithley DAQ6510 Digital Acquisition Meter, and a Logitech Webcam. The algorithm is executed serially, meaning each command is completed before moving to the next. This structure can be adapted for testing smart textiles by incorporating sensors and devices specific to textile testing.
- 2. Use of Archival ECP Files:** Flexdata includes an algorithm for using ECP files, which were originally used to control Yuasa motors and take measurements. This can be adapted for smart textiles by specifying the motor speed and number of cycles relevant to textile testing.
- 3. Template Customization:** The document mentions the ability to define templates with various test parameters such as resistance, voltage, temperature, humidity, load, or 4-wire measurements. For smart textiles, you can create a template that includes parameters relevant to the textile's functionality, such as resistance for conductive fabrics or temperature for thermoregulating textiles.

Here is an image that illustrates the setup for conducting experiments within the Flexdata system, which could be adapted for testing smart textiles:



These examples show how Flexdata's flexible algorithm framework can be tailored to meet the specific needs of smart textile testing by using the appropriate sensors and test parameters.

Ask: "Show Test Algorithm"

Show me the test algorithms for e-textiles stretching assessments

#5981 Feb 11, 2026, 4:19:47 PM

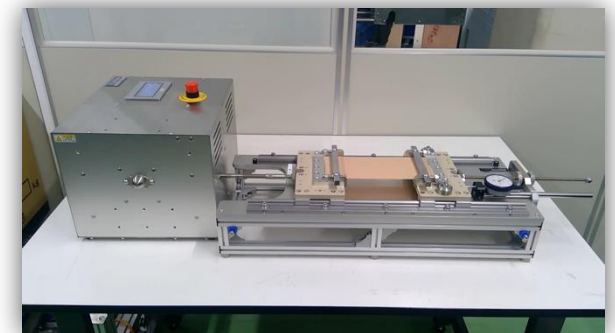
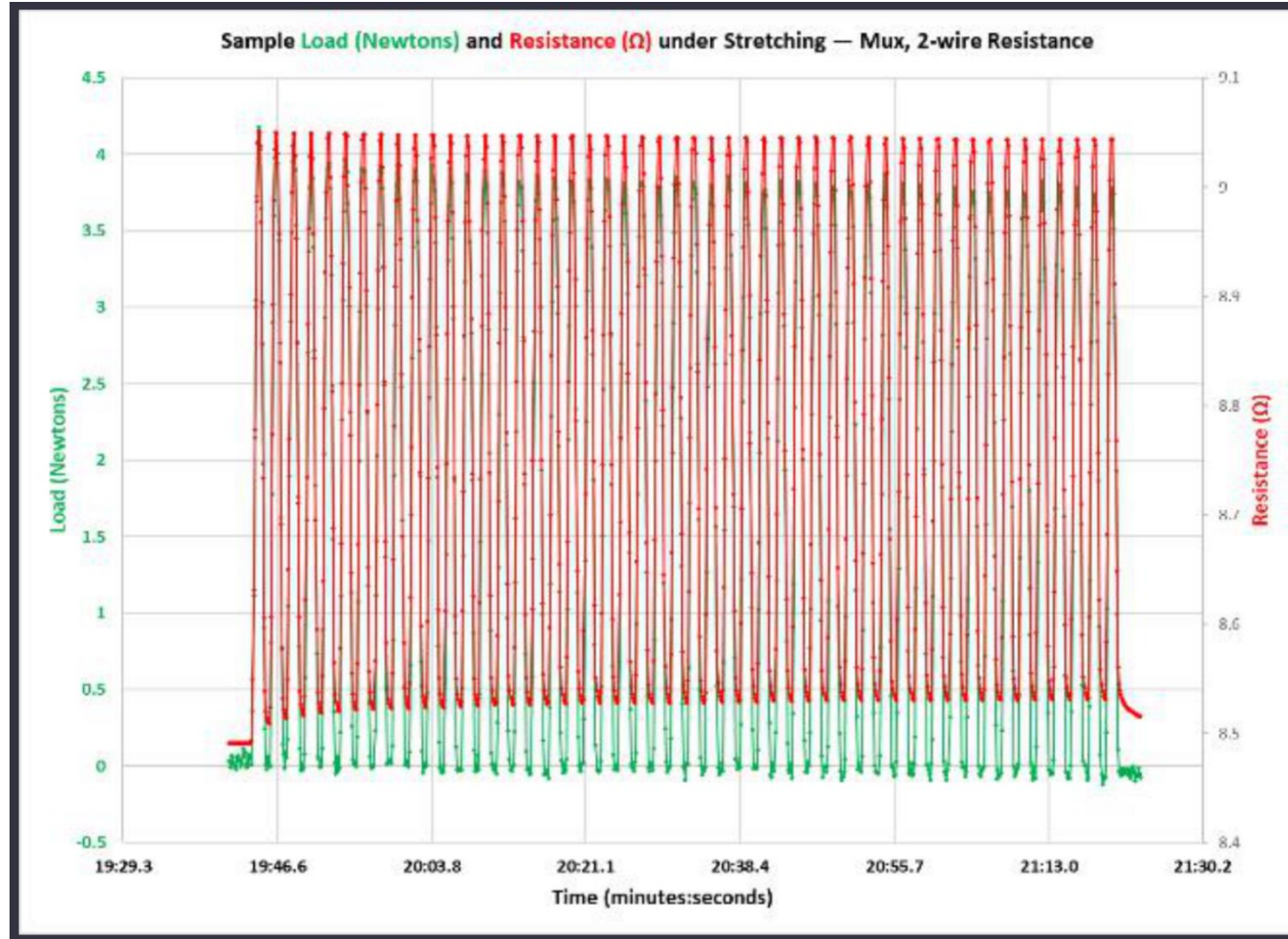
The Flexdata application note discusses how algorithms are created and used within the Flexdata system to control various test machines and data acquisition devices. While specific algorithms for e-textiles stretching assessments are not detailed in the provided context, the general process involves setting up templates and channels to measure parameters such as load and resistance during the stretching tests.

The procedure for stretching tests involves calibrating the load cell, setting the jig to the no-load position, and defining the stopping and stretching positions. The Linear Converter is adjusted for the specific conversion factor, and repeated cycles are conducted to measure minimum and maximum loads, ensuring precise measurement of stretching parameters.

For more detailed information, you can refer to the relevant images and descriptions from the application notes:

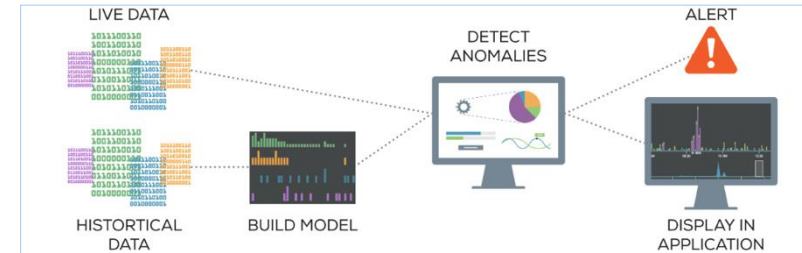
```
comment DR Stretch with Load Cell
comment Set Load Calibration Value on Template
comment Set Jig Position to No-Load Location
comment Set +SP and -SP and Stop Position
comment Sample is 115 mm, stretch 10%
comment DR / Linear Converter 1 mm = 3.183°
comment No-Load=0° Load = 11.5 * 3.183 = -36.6° Stop="+"
comment Tension is Positive, Compression is Negative
comment Record Sample Load and 4-wire Resistance
device DR apply Default
device DAQ apply DAQc-LC-Mux
Load calibration DAQ config DAQc-LC-Mux on Load
comment Get No-Load Voltage
experiment record
comment Get Max Load
move DR speed 100 count 1 Template override Sp+ -36.6 Sp- -36.6
experiment record
repeat 5 times
do
  move DR speed 100 count 3 Template override Sp+ 0 Sp- -36.6
  comment Get Min Load
  experiment record
  comment Get Max Load
  move DR speed 100 count 1 Template override Sp+ -36.6 Sp- -36.6
  experiment record
comment End at No-Load Position
move DR speed 100 count 1 Template override Sp+ 0 Sp- 0
comment Get Final No-Load Value
experiment record
```

Ask:
"Run Test"



Custom Software Development Anomaly Detection Module (Data + Images)

- **Purpose:** Detect and monitor anomalies in electronics over time.
 - Analyzes sensor readings (e.g., resistance, capacitance) and environmental factors (e.g., temperature, humidity).
Data framework with several nodes/relationships
 - Detects early signs of material or component degradation (e.g., adhesive deformation, substrate delamination, material fatigue) taken from continuous images / video
 - Predictive analytics + system maintenance for extreme environment displays and electronic components (possible to connect with manufacturing data & self correction operation)
- **Results:** Higher productivity with Multi-level, Multi-site Analytics and advanced applications (Approach proven in Pharma & Clinical development to develop materials database)



Computer vision methods:
Image processing includes
 * Noise reduction
 * Contrast enhancement
 * Colour space conversion
Image segmentation includes
 * Edge detection
 * Watershed algorithms (topology)
 * Image isolation
Eliminate contamination, light

AI Agent methods:
Provide Image Context
 * Features
 * Textures
 * Colour patterns
Analysis & interpretation to detect anomalies
Tuned for specific issues
From multiple series of images.



Image of adhesive layer
On substrate

Detection module (leonardo)

New Development: Workforce Training (Tiger)

AI enhanced workflows (Agentic AI) solves problems

Takes a LLM engine and adds automated Reasoning

Ties mechanical/electrical/chemical theory with Hands-on testing

For PhD students to improve skills for IME testing in harsh environments

Upload Theoretical Coursework (In Private Locker)

Semi automated module drop as an extension of Flexdata platform

Provides virtual Student/Teacher course prompts

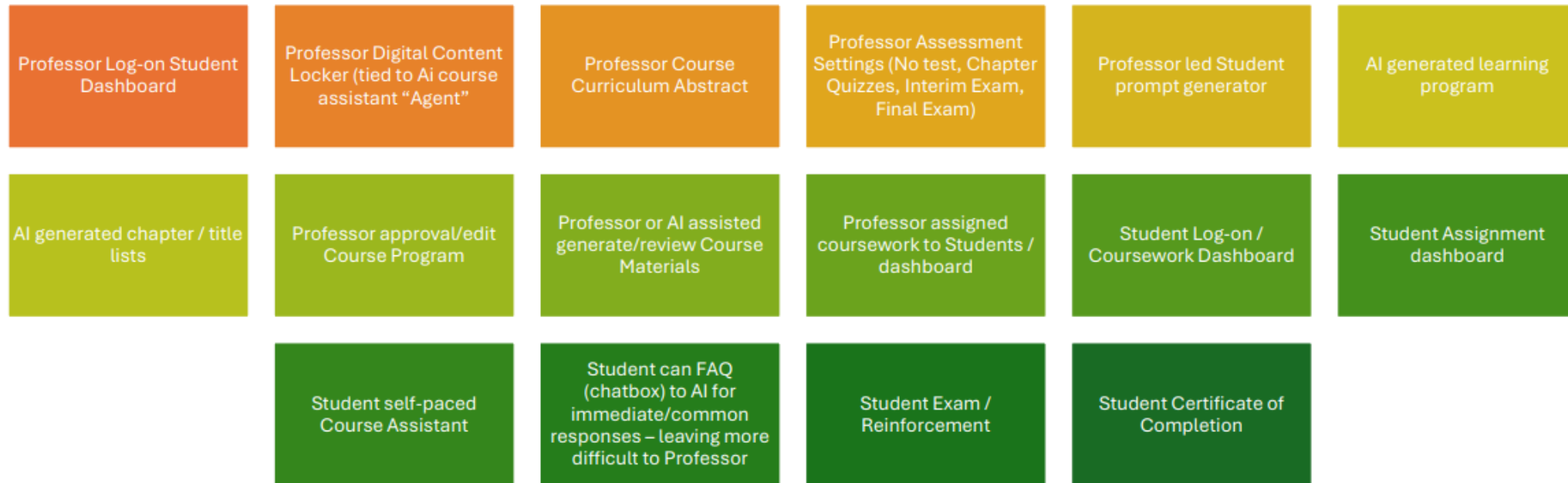
Monitors Student progression

Enables Self / Micro Certification for Workforce



AI Workflow functionalities

LLMs determine objective; Automates sub-tasks; Determines what tools are needed;
Optional Plug-ins to external systems



Upcoming Development: Cold Chain Logistics (Guardian)

Expand FHE enabled AI workflows to Clinical Outcomes

Requirement for Whole Process Clinical Innovation verified in moonshot innovation

Integrated use of AI leads to new value add for FHE products

Connect flexible sensors on Medical Packages (transplants, vaccines)

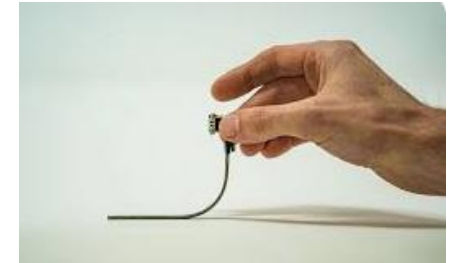
Extreme Cold, Vibration, Drops, Liquid leaks, Signal strength etc.

Monitor, Predict, Alert only when Incident occurs

Efficient Data Processing per each Unit Device

Automated to Instant Insurance Claim Process

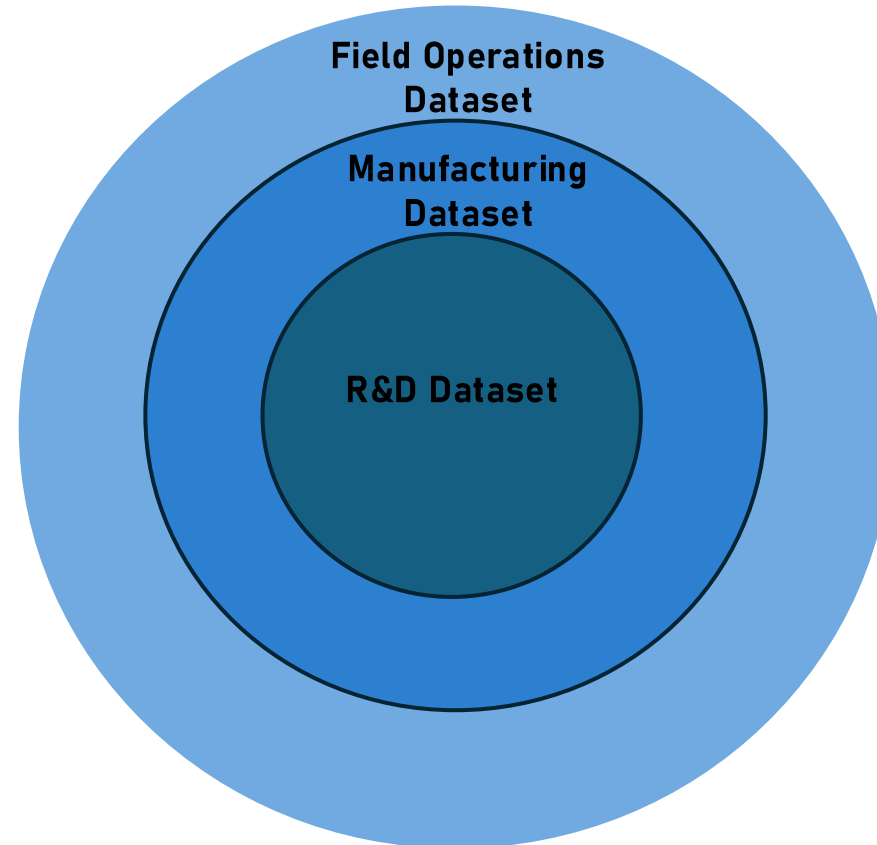
Faster Replacements, Contextual Evidence, Automated Claims



Long term Vision for Reliability Data foundation & extendibility

Constant Data spanning R&D, Manufacturing and In-field devices

- Lab Automation & R&D Data Set**
 - * Lab test development
 - * Manufacturing data analysis
 - * Field data analysis
 - * Dataset development & preparation
 - * Classification, Anomaly detection
 - * Prediction models
 - * Performance analysis
- Manufacturing QA**
 - * Manufacturing Testing
 - * Anomaly detection
 - * Product classification
 - * Data Collection
- Field Operations**
 - * Data collection
 - * Predictive maintenance
 - * Anomaly detection
 - * Performance analysis



Areas of further collaboration required

Part Identifier System

Batch lot
Manufacturer
Manufacturing Date
Anti counterfeit properties

Data Sharing with Manufacturers

Requires trust
Requires capabilities
Requires incentives

Sequential Data

Accurate tolerances based
Upon standard deviation curves

AI Capabilities

Potential of using more images
With AI fault recognition tools

Reward: Flexdata enables Operational Speed & Scale



Breakthru: Shifts focus from “what” to “why” from simple failure detection to automated data frameworks.
Provides specific cycle count where material degradation occurs.
Provides multi-level analysis by combining mechanical, electrical and environmental data.

R&D Productivity

By extending the Flexdata platform with AI tools, AI knowledge modules, “internal know-how” (documents, videos, diagrams) will support operators become senior data scientists

Workforce Development

Additionally, the AI workflow module will take course materials to provide automated certifications support, solving the “skill gap” in FHE advanced manufacturing

Scale

Manufacturers can now prove the Reliability of large volume runs, balancing appropriate costs ensuring lower costs as scale, enabling the FHE industry to cross the chasm

Beyond

Bayflex Solutions plans to further expand a “universal intelligence layer” for FHE systems, for edge products for efficient data processing into larger AI infrastructures

Enabling Next-Generation Aerospace Systems with Hybrid Electronics

About NextFlex

- America's Hybrid Electronics Manufacturing Innovation Institute
- A public-private partnership bridging industry, government, and academia
- Accelerates transition from R&D to manufacturing
- The NextFlex Technology Hub in San Jose, CA, is a full end-to-end hybrid electronics manufacturing line, available to NextFlex members and commercial clients
- Manufacturing roadmaps, project call funding, and over 200 members are at the heart of our consortium.
- Applications covered include Unmanned systems, Industrial, Communications, Medical, Wearables and Automotive, Aerospace and satellites.

Join us!



Aerospace Challenges

- Weight and wiring complexity limit performance
- Harsh environments require durability
- Need for distributed sensing & edge intelligence
- Long development cycles

What NextFlex Delivers

- Hybrid Electronics Manufacturing
- Lightweight, conformal electronics
- Reduced wiring & improved integration
- High-performance RF, antennas, sensors
- R&D → prototyping → manufacturing

Mission Impact

- Reduced weight, increased payload efficiency
- Real-time sensing & communications
- Improved reliability & survivability
- Faster transition to deployable systems

OE-A – Advancing the flexible and printed electronics industry

Driven by 180 international member companies & institutes from Europe, North America, Asia and Africa. We are the largest industry association for flexible and printed electronics today.

Primary activities include:

- » Working Group Meetings & Networking Events
- » Market & Technology Information
- » Advocacy
- » LOPEC: Conference & Exhibition

www.oe-a.org

www.lopec.com

OE-A members represent the entire value chain of flexible and printed electronics:

- » Component & Material Suppliers
- » Equipment & Tool Suppliers
- » Device Manufacturers
- » Producers/System Integrators
- » End-Users
- » Universities & R&D Institutes

OE-A is a working group within  VDMA

Thank you



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[#bayflex testing](https://www.youtube.com/hashtag/bayflex%20testing)

