Memorandum

Sent via electronic transmission

Our Ref No: M220740
Date: July 18, 2022

To: Program Participants

From: Eisuke "SK" Tsuyuzaki - Bayflex Solutions *Eisuke*

Re: **Smart Electrically Powered And Networked Textile Systems Research Program Statement of Capabilities**

To whom this may concern,

We are a Silicon Valley based company focused on developing, selling or renting Reliability Testing Systems designed for Flexible Hybrid Products including e-textiles.

Specifically with our partners, Yuasa System, providers of FLEXI award winning modular mechanical testers (e.g., stretch, twist, flex); we have modified and sold over 1,000 units worldwide including installations at the Picatinny Arsenal, SUNY Binghamton and Nextflex in Milpitas, CA.

Our laboratory automation software, data+image analytics which are optimized for these professional grade testers and other third-party devices have been co-developed with amongst the largest American Consumer Electronics companies and their supply chains.

We have modified various legacy environmental chambers and are developing a modular multi-climate (including altitude, liquids, gases and "natural shocks") which is integrated with these mechanical testers and data harvesting and analytics capabilities.

In short, we can together, provide reliability test data on newly prototyped multi-climate integrated mechanical tools for making meaningful decisions regarding test levels, test duration and performance factors needed for various usage scenarios. We can advance existing chamber systems to include newly-developed mechanical jig motion function and advanced analytical tools with optical integration.

We look forward to collaborating with you.

DUNS Number 117646399

(1) Our Background

Bayflex Solutions believes that the proposed project scope will result in the need for a technological tool for conducting tests and capturing data in harsh environments. The purpose will be to accelerate product reliability and development of FHE based products. Initially, we could make available existing mechanical testers and integrated kits for existing chambers. By implementing a modular architecture to integrated environmental chambers, we could provide flexibility and scalability to users and reduce development costs.

There are no known testing standards for flexible products in harsh environments for military grade applications. There are no known proven testing tools for integrated multi-environmental testing equipment. There are no common testing platforms for data analytics, meaning there is no way to share testing condition data between product developers, their suppliers and manufacturers. By simultaneously studying the environmental and mechanical reliability of FHE systems, it will be important to produce combinations of materials and components that can survive environmental cycling alone in order to isolate such causes from mechanical failures.

True FHE reliability testing needs to simulate realistic use-cases, and needs to provide data on how the FHE system, including textiles, substrates, printed traces, adhesives, conductors and mounted components react to these conditions. To simulate such conditions, both physical motion and environmental conditions are critical. Physical conditions include stretching, bending, twisting, etc. calibrated to the use-case and monitored for changes in performance. Environmental conditions include temperature, humidity, pressure and presence of salt or gases, and more often than not, a combination thereof.

Previously, many FHE reliability studies seems to have used "universal" testing machines which were designed to determine tensile strength but are not designed for FHE reliability testing. What will be more valuable is not destructive tests but the materials stress/strain relationship to determine fatigue failure. Similarly, we believe the common three-point bending test is not a realistic simulation of most use-cases as the common objective is destructive to the sample rather understanding the effects of continuous use. Other "home grown" testing equipment may have been adequate for initial needs, but do not reflect scalability and repeatability across multiple sites and organizations.

We are aware of many current FHE related standards in this realm such as IPC, SAE, JIS, IEC for acting as participants or observers or several de-facto standards and practices created by Apple, Google and Meta Networks. We have been recently requested to participate in SEMI facilitated effort to potentially explore MIL grade e-textile standards. It is our determination that no standards exist but as a group must seek to define and build such testing systems.

(2) Our Thinking – a Technical Approach

Bayflex Solutions believes that the project calls for multiple reliability testing activities to take place in parallel, at multiple team member locations, resulting in creation of new endurance test systems and knowledge of failure mechanics for component attach in harsh environments.

The first broad area will greatly accelerate the development of a heretofore unavailable capability for FHE. In order to develop a benchtop multi-climate/environment system (Project Pico) the team could built on a proven approach to designing modular endurance test systems using interoperable motor drives and mechanical test jigs that can be integrated into environmental chambers. While some existing test jigs are capable of operating in harsh environments and a prototype shown at FLEX 2019, the development of such a system with integrated mechanical test capabilities will require new components, structural design, and integration of external sub-systems (air conditioning, salt-spray, ultra-violet units) Likewise, Bayflex Solutions have developed simple lab automation software on Windows and Google Cloud, there is a need more sophisticated system controls (intelligent and predictive data measurement such as torque, resistance and temperature), multi-site, remote operation and advanced analytical software packages (single and multi-layer delamination, material deformation etc.) The availability of such a package will enable sharing of data across the FHE industry and support standards development.

The second broad area focuses on a rigorous set of experiments on a standardized test vehicles that enable controlled comparison of substrates, adhesives, mechanical stresses and environmental conditions in order to enable a deeper understanding of the reliability of rigid components attached to flexible substrates. Starting with ambient test, moving into testing in existing chambers and finally in the multi-climate Pico, the experiments will collect data on increasingly realistic operational environments. With the through review of previous studies and the results of experiments for this project, we believe we can support the development of standards constructing and testing FHE devices.

In a prior study in conjunction with ACI Materials and Auburn University, Bayflex Solutions makes the initial amended recommendations for Performance Target Metrics and or Specifications.

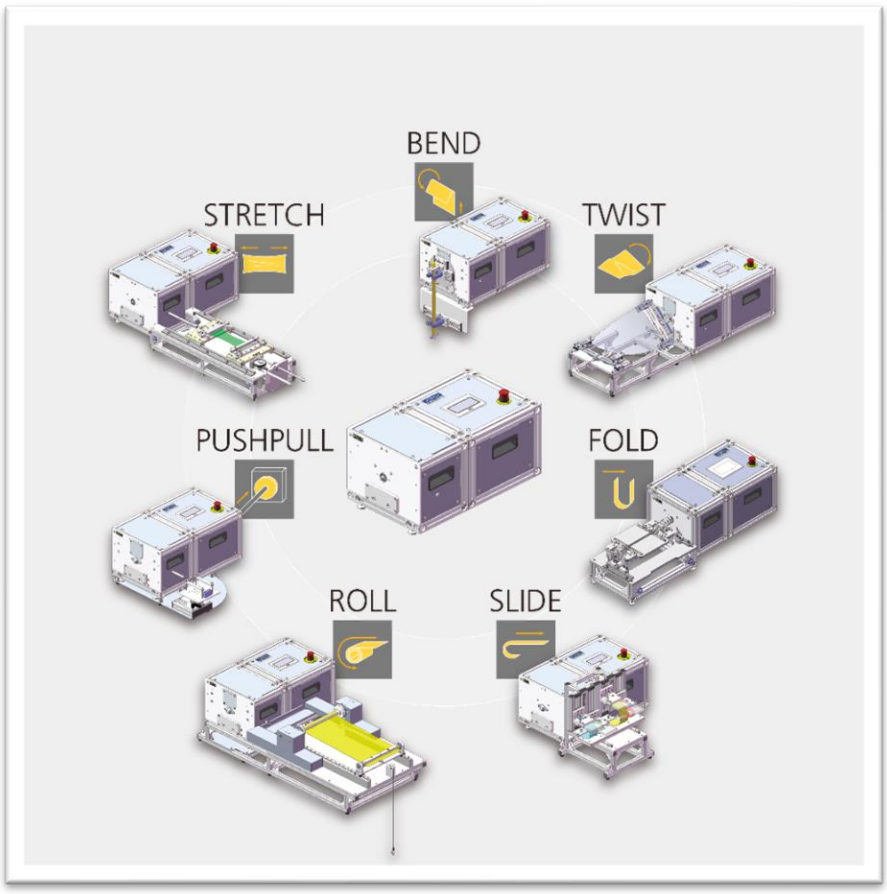
Number of Cycles of Dynamic Tests	300,000 cycles or until Failure
Frequency	1-30 Hz
Flexing Angle	10-180’
Flexing Angle	5- 40mm
Primary Mechanical Motions	Stretching, Twisting, Flexing
Temp/Humidity	40/60/70’c, 30RH

(3) <u>Our Experience</u>

Bayflex Solutions has worked with its partner, Yuasa System to design, develop and manufacture endurance test equipment which can accurately recreate realistic mechanical motion in a repeatable and reliable manner. As shown in Fig-1, these including bending, twisting, folding, rolling, stretching and pushing. To date, we have sold over 1,000 systems worldwide. Additionally, many these machines utilize a tension free mechanism of pulleys to eliminate the effects of counter-weight interference increasing the accuracy of data obtained.

Furthermore, Bayflex Solutions has developed the Flexdata lab automation platform to enable easier set-up of repetitive test coupons, plug and play integration of select third party devices such as Keithley and Hioki DAQ and meters, Dinolite digital microscope, IDS camera modules, Unipulse load cell and torque meters in addition to Yuasa motor drives. Flexdata provides a data and image framework for predictive

analysis such as automatically taking more measurements when the test approaches breakage to easier determine failure causes.



Thirdly, Bayflex Solutions has experience installing test equipment in a variety of existing environmental chambers; Yuasa has developed it own compact environmental chamber, and Bayflex has integrated in existing chambers (Zeiss/CSZ, Thermatron, Binder, Etac) including single or tandem operating configurations. Bayflex previewed a small operating prototype of the Pico, a multi-conditioned environment in an acrylic casing with linear motion stretching functionality with strong magnets at FLEX 2020.

(4) Our Team

Bayflex Solutions is based in the San Francisco Bay Area and was founded in 2015 by Eisuke Tsuyuzaki. Graduate of Sophia University, Tokyo, UCLA and Stanford. Prior to founding Bayflex Solutions, he was the Chief Technology Officer at Panasonic (NA), overseeing new corporate initiatives in media, medical and automotive and clean energy solutions. Previously was an executive at Sony Corporation and Sony Pictures Entertainment. Technical Emmy recipient in 2013 and Home Media's Visionary of 2010. He leads Bayflex Solutions' corporate development & engagement activities.

Robert Hopkins is Bayflex Solutions, Senior Fellow and oversees all mechanical testing technical support. Graduate of Purdue, Rutgers and Harvard. He has held executive positions at Sony Pictures Entertainment, RCA Corporation and was the Executive Director for ATSC. Emmy recipient.

Leonard Sheiba is Bayflex Solutions, Chief Architect and oversees software services and support. He leads Kibernetika.AI and has started and exited from numerous start-ups and technical endeavors.

(5) Our Ambition

In conjunction with lead investigator(s) and collaborators, Bayflex Solutions believes it could best contribute and serve this project as it has always done, as provider of flexible electronics reliability systems. Per the project's timelines, it could deliver to any/all potential partner(s);

Make available existing endurance test equipment, to establish testing objectives which could be used as a baseline for evaluation of mechanical motions (including flexing, stretching, folding etc.) in ambient environment, to compare for example, the mechanical motions to human motions, to compare the automated mechanical motions to hand-built test systems, and to improve test efficiency with repeatable, long-run endurance tests. To this end, professional grade desktop motor drive units and various mechanical jigs could be available in limited quantities.

At the second phase, Bayflex Solutions could integrate certain mechanical jigs in existing environmental chambers. The test fixtures will be incorporated in thermal chambers for the purpose of testing. The integration of test fixtures into thermal chambers could allow for the study of multi-environment reliability of FHE under stresses of temperature, sweat and mechanical deformation including flexing, folding, twisting and stretching. Bayflex Solutions if accepted, will commit to develop the Flexdata platform for further lab automation, including potentially robotics integration and remote operation. Not only will it measure electrical parameters, this middleware provides the key functional blocks for lab equipment set-up, experiment planning, monitoring and data management.

In the final phase, Bayflex Solutions could develop the aforementioned Pico multi-climate integrated with mechanical testers. Aside from a modular approach to various climates and conditions, with initial optical integration for hostile conditions, will refine more complex mechanical motions, and will continue to development of predictive software packages focused on detection and of delamination and material deformation in conjunction with various material and device developers. Such a system will enable operation of moveable modular environments for harsh conditions. By developing hermetic sealed enclosures will allow safer and complex testing environments (e.g., Lithium battery tests, COx, altitude and natural shocks and bump test) Such modular architecture extended to hostile conditions will enable the development of cost sensitive, scalable and flexible design.

Further information can be obtained at www.bayflextechnologies.com
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