FUTEK
ADVANCED SENSOR TECHNOLOGY, INC.

Mission Impossible
Designing a System That Can Go Into Space

The Challenge

The project, designing a specialized sensor for NASA, originated at Harvard University where student Shelly L. Anna began its research. It later needed the help of Massachusetts Institute of Technology (MIT) Dr. Gareth H. McKinley where they faced many difficulties reaching the NASA project requirements. Following an extensive search in the sensor market, Shelly L. Anna of Harvard & Kirk Logsdon of NASA chose FUTEK Advanced Sensor Technology, Inc. (FUTEK) to design and create a sensor device which would be used for measuring the difference of a liquid's reaction forces on earth vs. its reaction in space, better known as "liquid separation". The project, later named Sheer History Extension Rheology Experiment (SPHERE), involved numerous back and forth meetings in order to fulfill the needs of NASA and build a sensor which would be successful in achieving their goals. This project required a customized sensor with the ability to measure extreme low force value, specifically defined as a load cell (A transducer which converts force into a measurable electrical output).

This particular Load Cell had to be carefully designed to endure the initial aerospace launch impact as well as the conditions in space which would have influenced the sensor's performance. In order to achieve optimal results the sensor needed to be an extremely low capacity Load Cell (10 K Dyne) max, which is roughly 11 grams. Within this process, the project evolved and required several stages and models before reaching a final solution.

The Solution

In the first stage, which began in the mid 1990's, Shelly L. Anna contacted FUTEK with the need of a specially designed sensor. This sensor was part of a project which would be used by NASA in a microgravity research study to be conducted on the International Space Station (ISS). FUTEK's Engineering and Production Team worked together in order to come up with a custom Load Cell able to meet NASA's low capacity requirements. The first model constructed was the L2338-Q14339 Load Cell. Several years and stages later, after the sensors survived several rocket lunches and fulfilled the original test requirement the project came back to FUTEK with new requirements. NASA engineers discovered that the sensor required additional specifications, such as remote zero balance and fast dampening rate. These were the main obstacles FUTEK Engineers faced which required them to start the project with a fresh approach. The first task was to design a sensor capable of measuring the viscosity properties of complex polymer fluids. The sensor particularly needed to measure milligram forces a fraction of a gram under extreme condition.

FUTEK first decided to start from scratch and went back to using semiconductor strain gauges with much higher gage factor instead of original foil strain gages. They discovered that this option created higher noise levels and sensitivity to temperature changes giving them erroneous results. Determining this, they then realized they needed a Load Cell which was impervious to noise and temperature variations. After the failure of semi conductor gauges, FUTEK engineers went back to using thin film strain gauge technology. Design improvements were also made to the structure by thinning the Load Cells structure and an Overload Stop was implemented to help protect the Load Cell in case the force applied was beyond the units' capacity

tolerance. With these improvements, the transducer was able to survive the launch into space of 3-4gs. To solve the liquid separation-dampening requirement, a polymer was placed on the flexure. Although the process sounds simple, the team had to go through several trial-and-error processes to reach this solution. A customized-space qualified amplifier that took the low millivolt output and amplified to a 2 VDC full scale while maintaining a low signal to noise ratio and optimal accuracy was a major undertaking. The very low level signal was also needed to be created in order to reach settings at the required output. Various space requirements such as space rated and qualification of correct materials, wire management and routing also had an affect on the sensor's design and performance.

In hindsight, many of these solutions appear simple, like a solved puzzle. What often are forgotten in such projects are the countless hours of testing, design reviews, and brain storm meetings where ideas can be discussed and challenges reviewed. Most importantly, the business environment has to embrace a unified team structure for this kind of program to be successful. The SPHERE project is a good example of how a solution minded engineering team can be challenged repeatedly to produce successful result. Few companies may embrace such challenges but FUTEK has built its reputation in the market by taking on such feats. As an engineer, challenges such as these can be very frustrating and restraining at times limiting one from reaching their initial goal; however FUTEK Engineers were able to face these challenges and prevent them from becoming a barrier by working as a team and collaborating their ideas. Using all of the resources available to them as well as the experience they've acquired through previous projects, engineers were able to devise ways in which they could develop the process in reaching a solution. FUTEK's diversity in the market and in product applications are qualifications in which helped them to create solutions that worked for NASA.

Using an existing FUTEK high precision Model LRF400 Load Cell as a design base, they were able to modify and improve the product to meet the specific requirements of this particular project. The standard model was chosen due to its small size, housing, and lightweight design. It helped FUTEK to define the "package" of the product and transform it into a customized design. Through several tests, FUTEK developed a method of calibration which later proved to be valid in space and effectively overcame the problems they faced. They developed a solution which helped dampen the Load Cell with a very low capacity at an extremely fast rate. The final product weighed a total of 6.3oz., and was successfully launched on October 23, 2007 in NASA's research project SPHERE on the International Space Station (ISS).

Conclusion

After contacting over 38 other companies, NASA chose FUTEK for this particular project. FUTEK was chosen not only due to our willingness to take on the project and its requirements, but also because of our proven track record. Our ability to take on challenges such as this and overcome the obstructions they may entail has proven FUTEK to be a qualified Sensor Solution Source. FUTEK has taken on and successfully delivered many difficult projects which, has further developed and demonstrated FUTEK's creative capability while gaining experience and knowledge with the most unique applications. As a result, FUTEK has been able to expand our standard product line and continues to do so offering the most innovative and creative sensor solutions in the field, such as our USB Sensor Solution. FUTEK has the resources, experience and capabilities of supporting any application or challenge given to us. We have used these experiences and the combination of improved electronics, fabrication, and wire EDM to develop new lines of products, such as FUTEK's LSB200 Jr. S-beam Load Cell and USB Sensor Solution which, you can find on the FUTEK website.

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Challenging experiences such as the NASA project and many medical related programs among others have stimulated FUTEK Engineers development and creativity within the field allowing us to push the envelope and create the most unique Sensor Solutions. FUTEK is uniquely positioned to produce sensors and related instrumentation using certification and compliance to ISO13485:2003. By doing so, FUTEK has raised their standards and is able to provide quality products and solutions for all industries including medical, nuclear, aerospace and automotive. Our qualified engineers welcome any challenges you may have and guarantee we can help support you in finding a solution.