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Why Test Airbags?

In any engineering endeavor, there are usually numerous reasons to test the product as it progresses from engineering concept to engineering prototype to pre-production model to full production. Each stage has its unique needs and demands.

In the engineering phases, it is important to verify that the design performs as planned under various controlled environments. For engineering, the important concepts are complete data collection with integrity plus maximum flexibility to accommodate the many different aspects of the device. In addition to flexibility in performing various tests, there is also a need to ensure that a second test, if needed, is identical to the previous one so that the comparison of test results is faster and easier. Thus, the ability to absolutely replicate a previous test is important.

In production, there is more of a need for verification of quality to ensure only products that pass a standard ship. Here the need is for quick, safe, and error-free setups. The test procedures must be consistent across operators of varying skill levels, and ensure that no short cuts are permitted for safety and data integrity reasons.

Overall, testing helps validate good designs, verifies good production, and thus limits waste and liability. Let's examine the many reasons to justify testing, as there is the issue of whether to test at all. One could simply perform an electrical or physical inspection or a crude deployment (without any triggered video or data monitoring) - just to see if the bag deployed. However, there is still a question of determining whether it deployed properly.

Corporate Management

Competition: Your business is more competitive than ever. You need to do everything possible to keep your existing customers and attract new business. Of course, your automated airbag test system will allow you to save costs, improve productivity, and make better product and process decisions. What it will also do is demonstrate your company's long-term commitment to quality, to providing the tools that your staff needs in order to do the job. Many

companies will turn their automated airbag test system into a showpiece, and include it on every tour and display pictures in their marketing materials.

Customer Requirements: Your end-user customers, current or future, may require deployment testing as a contractual condition to ensure quality and limit liability. Many customers install a deployment system because their customer told them than it was required as part of the contract (sample testing with data collection). In fact, a deployment system may be critical to land and keep future business. Revenues and profits may be less vulnerable and customers more satisfied with the test results from an automated deployment system.

Engineering

Data Integrity: In engineering phases, your handcrafted prototypes may cost many thousands of dollars to build and be one-of-a kind. Your main engineering purpose is to test and validate your new designs or changes to designs – this requires valid data that can be relied upon all the time. This assists engineering in maintaining your proper ISO procedures concerning test data within the company. If the deployment goes wrong with a non-automated deployment that is, there is a possibility that your crucial test data may be lost, invalid, or never recorded. In fact, a repeat of the test may not be feasible with a truly one-of-a-kind prototype. This implies a very large financial risk to your corporation in terms of dollars and time.

Engineering Data Requirements: Airbag testing for new product development can have as many as 32 channels of sensor data if you are performing out-of-position (OOP) testing on a side airbag. Even during lot acceptance testing (LAT), you may, on occasion, be supplied with an airbag that has a pressure port. To this pressure port, you hook up an internal airbag pressure sensor, and cable back to your automated airbag test system. The automated airbag test system will provide power and signal conditioning to the sensor, anti-alias filter the data, convert the raw signal to engineering units such as psi or kPa, and store the data in a commercial format for easy access and analysis. While this analysis can be performed by using an oscilloscope, your operators could spend hours downloading, converting, and organizing the data into a useable, savable format. An automated airbag test system will do this consistently and reliably, and provide the data for analysis within seconds following the deployment. Isn't that what computers are for?

Your customer has asked you to provide data to verify that the airbag you deployed 6 months ago was actually soaked at +80C for the full 4 hours, as per the specification. You can spend hours looking through filing cabinets filled with circular paper charts, try to figure out how to mark your time zero on the chart, and then take a guess what the temperature really was because the pen in the chart recorder was running low on ink and the chart has faded. Today's automated airbag test systems treat temperature data as important test data, measuring and saving it digitally, and archiving it along with the rest of the test data for easy recall.

Dual-Squib Deployments: With dual stage airbag technology becoming more common, it is increasingly critical to ensure that the timing between firing the two stages is accurate and reliable. Engineering parameters to be controlled and varied are amplitude, pulse duration, and

delay between pulses. At the same time, all of your timing measurements rely on knowing what is "time zero" or T_0. An automated airbag test system will control the firing of your airbag, trigger your high-speed video cameras, and trigger your high-speed data acquisition equipment to ensure that you have a consistent time zero. With this important factor certain, you can take accurate time measurements of first movement, peak pressure, full inflation, and other performance parameters.

There is also the question of what to do with or how to dispose of a "live" and dangerous squib (the explosive). The ability to fire the second squib not needed as part of the test, is important for operator safety, as the "unused" squib can be safety fired after the event recording is over.

Test Analysis/Conclusions: Why did the airbag you just fired reach full inflation after you expected it to? Was it a defective airbag, or perhaps the cover, instrument panel, or seat that impeded its progress? Your first check should be to determine if both the primary and secondary stages of the airbag fired. You can check this via x-ray analysis or by simply looking at the squib current readback data that your automated airbag test system acquired. If you see that current flowed through the squib and the squib broke down, you can be reasonably certain that the airbag fired as expect. If there was no squib current on either stage, then the problem is likely with the airbag module and not with the airbag cover, IP, or seat.

You test your product in order to make important quality and performance evaluations. You can do this the easy way or the hard way. The hard way is to force operators to measure from TV monitors or paper plots. Perhaps they can hold up multiple paper plots to the light to see the difference between test samples. You can give your operators two VCR's and two TV monitors, and with one remote control in each hand, they can "synchronize" the playback from two cameras. Don't laugh, there are still some companies operating this way. Obviously there is a better way. An automated airbag test system will acquire and save your data in standard digital formats, and provide you with analysis tools to allow your operators to quickly and easily understand the data. They can display multiple camera views from multiple tests, synchronize their playback, and even synchronize their sensor data with their video data. All measurements are as accurate as the data allows, no more guessing or fudging of data is required.

Production

Safety Interlocks: An automated airbag test system provides for control over all your safety interlocks such as emergency stop switches, warning lights, warning buzzers, door sensors, electronic door locks, and ventilation. Under control of the automated test system software, the safety interlocks ensure the safety of you and your operators. After all, while the purpose of an airbag is to save lives during a collision, it is an explosive device and potentially a life-threatening component that needs to be treated with respect and with care.

Even with only crude deployment testing, there remains a need to ensure the safety of the operators and surroundings by building a basic deployment "room" and putting in some basic safety interlocks such as door locks, door sensors, emergency stop switches, warning lights, warning buzzers, and ventilation (for dust and toxic residue). Whenever, non-expert employees

are used, there is a possibility of either setup or procedural errors that can endanger the operators or fellow staff. A fully integrated system can control all these aspects and ensure data integrity for engineering analysis.

Automated Setups: With so much equipment to configure and setup prior to each test with critical data conversion and manipulation, the alternative to using an automated airbag test system is to hire a full time, highly trained engineer. The better decision is to save this money (and headcount) and allow the automated airbag test system to do the job. Not only does this approach result in better data and faster decisions, in the end, it is also less expensive. Your boss will appreciate the cost-savings and your customers will appreciate the improved quality and integrity of your test data.

A key to good, automated production testing is to remove from the operator, as many of the choices and workload as possible. A good system should have a simple interface that allows the operator to choose the test-type and then START the automated procedure. Once started, the operator interaction must be minimal, such as "Confirmation" (or FIRE) of the desire to continue the test at various stages. Once completed, the test data should be stored automatically and the system is then automatically re-set to begin anew or repeat the same test without any further effort. With the ability to select a pre-defined test setup or profile, there is a greatly reduced possibility of operational errors, thus test results become more consistent and more readily accepted by all concerned.

One of the more important components of an automated airbag test system is the high-speed video cameras and related equipment. Prior to deploying an airbag, the cameras must be correctly configured with the proper recording speed, exposure, color balance, and pre/post trigger frames. The photographic lights have to be turned on just prior to the deployment to reach the correct color temperature, but not too far in advance or they will heat your test samples. A hardware trigger must be provided at exactly time zero, which is the time that the airbags begin to fire. Following the deployment, the captured video data must be retrieved, color corrected, and converted from the native format (often Bayer) to TIFF or AVI. Then the data must be archived with a directory structure convention that will make it easy to find the data later. This procedure can be performed manually using the basic control panel software that comes with the camera, but this approach is time consuming and is prone to mistakes. A mistake in this procedure can mean that you do not capture any of the video data at all! Even if no mistakes are made, your operators will have to spend between 30 to 120 minutes for each test, doing what your automated airbag test system can do reliably, consistently, and faster. This frees up your technician to perform more important tasks, such as sample preparation.

From properly setting up the high speed cameras, to ensuring that the squibs, cameras and data acquisition all start at time zero, to properly converting and saving the video and sensor data, an automated airbag test system can perform these tasks reliably, consistently and faster than a manual solution. This frees up time for your operators to do other, more important tasks. After all, doing "more with less" is how business is done in the 21st century.

Quick Quality Check: In LAT, without high-speed video and squib current monitoring, there is no other way to positively confirm whether the airbag modules are being properly produced.

Your corporate ISO policies may demand a certain number of sample deployments with data collection. If there are suspected production or component problems, which may affect how the bag deploys, the modules would need to incur the cost and time to ship to an off-site facility for testing. This step can take many weeks and results in wasted production and possible costly product recalls should the problems be real. The delay between deciding to test and getting results may easily exceed a month. During this time, production may still be producing faulty devices, thus generating more scrap.

If a bag fails to deploy, how does your operator determine if it was due to a "bad" product or a system problem. An automated system gives positive feedback, such as with an optional squib resistance measurement prior to the deployment, to ensure wiring integrity from the system out to the squib. Another indication would be the captured squib current waveforms and images.

System Cost Justification

If a facility produces 50,000 airbags per year, this presumes that it makes some 200 bags per day, 250 days per year, and tests at least one bag every day (defining one day as one production lot). This generates 250 test deployments per year. Actual tests will vary depending on contract demands and needs. For example, one company requires only one sample for each shift, whereas another company requires one sample for every hour of production. Engineering deployments are usually much fewer and occur in spurts, usually with tight schedules and a need for maximum flexibility to fully test the device.

External test costs can range from USD$750 to USD$1,500 per deployment plus any shipping costs. Based on the lower value (which is a typical cost rate for Detroit, MI, USA), this yearly test outsourcing amounts to approximately USD$190,000 or about USD$15,800/month. However, it is unknown if there exists, a local facility and what the actual cost per deployment would be at that facility.

A simple yet fully automated Microsys ***SureFire***™ LAT Deployment System can be installed for about USD$130,000, based on using a single color HG 100+ camera and no high-speed sensors other than squib current. Some other considerations are costs for the facilities (appropriate space, electrical, ventilation) and an optional temperature chamber (for engineering needs). You can perform all testing at ambient temperatures, and the facilities related costs should be much less than in the US. Thus the total installed cost for a Microsys Deployment System could be as low as USD$150,000. Other engineering needs that could increase system costs might include the use of various high-speed sensors, multiple or higher speed imagers, database capabilities with web-based browser support, etc.

Based on a cost of USD$750/test, the simple USD$130,000 LAT system, has a calculated payback of less than 9 months ($Cost_{System}/Cost_{OutSource/Month}$) when compared to outsourcing (not including device shipping costs). In terms of number of deployments, the payback would work out to fewer than 175 deployments. For a higher external cost per test deployment, the payback would be faster (i.e.: at $1,500/test, this relates to about 4¼ months or fewer than 86

deployments). The payback would be faster if you choose to employ used cameras. The payback would be longer if you need to have two camera views or other additional capabilities such as engineering sensors.

Notice that in no case was the cost of labor taken into consideration. This is because without the proper equipment, no technician, at any cost, could positively confirm a correct deployment or identify a problem – the event is just too fast for a human to monitor. The best an observing technician could hope to offer is that the airbag "deployed" with no data to back up the claim.

Summary

A fully automated deployment system can pay for itself in a very short time and help provide better devices, backed up by data collection and analysis tools. Without testing, there is the strong potential of creating "poor" devices. A world-class deployment test system helps create a world-class facility, whether for engineering or production.

Automating your airbag test procedures will mean that your operators can do more things within their busy day. Using technology to improve technology is smart.

SureFire is a complete, integrated Microsys Technologies Inc product, providing a safe and automated airbag deployment test system that automatically saves all images and sensor data. All settable squib parameters are operator controlled via a password. Loadable and savable "test profiles" simplify setups and ensure consistent testing procedures to help validate your internal ISO policies.

Once saved, **PowerPlay**™ provides analysis tools for the data and images with the ability to "playback" all data, even from multiple tests, in a time-synchronized manner. Linear and angular measurements may be performed directly on images and sensor data may be subjected to SAE J211 filters and other math and statistical functions. Additionally, the user can generate AVI movie loops for distribution and professional Microsoft Excel-based reports, based on templates that they control.

For more information on automotive occupant safety, visit the following web sites:

NHTSA: Nat Highway Traffic Safety Assoc.	http://www.nhtsa.dot.gov/
Insurance Institute for Highway Safety	http://www.hwysafety.org/
SAE: Society of Automotive Engineers	http://www.sae.org/
SAFE Association	http://www.safeassociation.org/
Test Group	http://www.testgroup.com/
Microsys Technologies Inc	http://www.micro-sys.com/

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