By Bob Neves

The Meaning of Life

New products, new designs. But still the age-old question persists, "How long will it live?" Terms like "infant mortality," "fatal anomaly," "long-term reliability" and "latent defects" are thrown around when speaking about product life. There are also a host of acronyms associated with this branch of astrology prediction, most of which are so important that they have been bumped up from 3 to 4 letter acronyms, ESS (Environmental Stress Screening), IST (Interconnection Stress Test), HAST (Highly Accelerated Stress Testing), HALT (Highly Accelerated Life Testing), HASS (Highly Accelerated Stress Screening), MTBF (Mean Time Between Failure) and Burn-In (First on the seen, entrenched before someone came up with an acronym). There is a whole branch of palm readers—I mean scientists and engineers—whose job it is to predict the life of a product. You remember the part in your car, TV or stereo that goes out days after the warrantee expires? Well, these wizards are the ones who predicted that fortune. How do you think they came up with the warrantee terms in the first place?

How to Deal With Stress

I can't wait 25 years to see if my design will last. Is there any way you can speed that up? This question is at the heart of the "life expectation" issue. The current direction of this mystic exploration is toward accelerated stress testing. The basic premise of this area of necromancy is that by increasing the amount of stress a product sees, the time of the product's death can be accelerated in measurable increments. Correlating the "measurable" acceleration to actual non-accelerated life expectation is the trick. Quantifying the stresses a product will see during its life can be accomplished by thoroughly evaluating the mechanical and environmental stresses the product will see.

Mechanical stresses are typically defined in terms of the shock and vibration experienced by the product in both operating and non-operating environments. Operational mechanical stress relates to the dropping, shaking, rattling and bumping the product is expected to see in the real world during operation. Non-operational mechanical stress experienced during delivery, set-up and storage are typically the worst mechanical stresses the product will see and must be considered (remember the gorilla in the American Tourister commercials?).

Environmental stresses are typically related to the atmospheric conditions the product will experience during operation (thermal, moisture, light, weather, pressure, etc.). In order to plan an effective environmental stress screening program, you must determine all of the environmental conditions that will be present during operation, storage and use of the product. In many cases, the product will generate an environment of its own during operation.

If a company is going to be serious about performing accelerated mechanical and environmental stress testing, it is important to evaluate both the operating and non-operating environments. Consideration must be given to both the mechanical and environmental stresses the product will see during its life.

Uncontrolled Stress Kills

One of the most common types of life and reliability test employed is the GUESS (Grossly Un-Correlatable and Exaggerated Stress) test. There is much literature thought to exist about the GUESS test, and people recount experiences and data obtained from GUESS testing like they would a UFO abduction experience. Many GUESS tests have their roots in ancient history. I believe to this day that Moses brought down MIL-STD-202 from the mountain (the really good tests were smashed on the rocks). It is apparent that many companies reference various types of GUESS tests in their product specifications and requirements.

There are some similarities between all GUESS tests. I have come up with a few basic guidelines for you to create your own GUESS test: The people in marketing have control over the laws of Physics in our universe; only the parts of the product that you believe will be affected are affected; knowledge of the product's end-use is unnecessary; parts are parts (all materials are created equal); the last design we built hasn't come back yet (it must be reliable); if two hours at 90°C correlates to five years on the desktop, then 200 hours at 150°C correlates to ten years of operation in Death Valley.

In lieu of the GUESS test, many com-

Bob Neves has spent the last ten years as the director of technical services for Microtek Laboratories, an independent test facility. Prior to his tenure at Microtek, Bob worked in quality management and engineering in PWB manufacturing. He currently serves as the IPC's Rigid Board General Committee chairman, Rigid Board Test Method Task Group chairman, Laboratory Qualifications (IPC-QL-653) Committee chairman, member of DESC's Tiger Team for MIL-P-RRRRR (MIL-PRF-31032), member of Blue Ribbon Committee for MIL-S-XXXXX (MIL-PRF-5X) and convenor of IEC TC52 Working Group 10 Printed Wiring Test Methods. You can reach him by e-mail at BobNeves@thetestlab.com or at the company website: http://www.thetestlab.com.

panies promote the *Spock* approach to life testing. This approach consists of the shipping clerk raising his right hand, parting his fingers and saying to the product, "Live long and prosper" just before the truck arrives to take it away.

Product Screening

Burn-In: Typically described as a functional test which lasts for a short period of time (typically less than a day) in an environment which would simulate a "worst case" operational environment.

ESS (Environmental Stress Screening): The use of environmental stresses on a product with a limited duration. This testing is typically performed at a stress level which, it is believed, will not significantly reduce the overall "life" of the product. Examples of ESS testing include thermal shock, vibration, thermal cycling, temperature/humidity exposure, physical shock, etc. ESS testing is designed to induce "latent defects" and screen out "infant mortality" cases without causing significant damage to "good" product.

Life Testing (Reliability Testing)

HASS (Highly Accelerated Stress Screening): A more aggressive screening procedure involving environmental stresses, such as thermal cycling, thermal shock, vibration, mechanical shock, etc. HASS Screening is designed to induce "latent defects" and "infant mortality" to failure more quickly than ESS. Accelerating the testing with higher stress levels can translate into causing significant damage to good products.

HAST (Highly Accelerated Stress Testing): This is a test which is typically used on product prototypes to induce failures with very high stress levels. This can help determine which portions of a product are less robust and allow the product to be improved in those areas. The failure mechanisms found during HAST testing may or may not have any connection to failures which might be experienced by the product in its end-use environment.

HALT (Highly Accelerated Life Testing): This is a test which is typically used on product prototypes to induce failures with very high stress levels, but is still related in some way to the operational environment of the product. The failure mechanisms found during HALT testing, may or may not have any connection to failures which might be experienced by the product in its intended end-use environment. HALT testing is an attempt to further accelerate an accelerated reliability test and, if not careful, may provide results similar to the GUESS test described above.

Predictions of Reliability

Companies spend a lot of time talking about the reliability and life of their products without actually knowing the reliability of their products. The results of accelerated life testing must be carefully considered before you classify product as "good" or "bad." It is important to compare results to a well documented baseline and to collect data from a significant sample size in order to get an acceptable mean value from a reasonably large distribution. Reliability predictions, after all, are just that—predictions. Astrologers and Tarot card readers make predictions as well, and it is important to weigh the reliability data obtained from accelerated testing accordingly.

Thanks to Werner Engelmaier of Engelmaier Associates for his insight on product reliability.