Optimizing Equipment Reliability Data
For End-Users and Equipment Suppliers

H. Paul Barringer, P.E.

Acquiring good life data for equipment sounds easy. In many ways, it is a difficult task. The data acquisition task is as difficult as taking beautiful and salable photos with a camera. Photos are advertised as easy to acquire. However, few candid photos are sold and used in professional literature. Taking a beautiful photo requires:

1. Good data logging equipment i.e., camera,
2. Knowledge of art and science of photography,
3. Careful illumination of the subject,
4. Clear understanding of the photo's purpose, and
5. Photo appreciation for either art or commerce.

Failure of just one element results in a useless photo. Not all photos made by the experts are salable—some (most?) are junk. Trying to take a beautiful photo by simply walking down the street taking snapshots won't produce good results unproductive. Taking a good photo requires a carefully constructed plan—it doesn't just happen!. Similarly, acquiring photos rapidly is equally

Abernethy (1996) says acquiring equipment failure data has three basic requirements; and for commercial businesses, add two other elements:

1) Define an unambiguous time origin,
2) Define a scale measuring the passage of time,
3) The meaning of failure must be entirely clear,
4) Measure cost consequences for failure, and
5) Gain data analysis expertise for using data.

A thoughtful plan to acquire a few pieces of carefully logged equipment age-to-failure data is better than vast quantities of unplanned data. Notice the parallels between photography and failure data.

Often people feel they lack any data (Barringer 1995) when in fact, data is all around them in various degrees of usefulness. Most industrial plants have been acquiring equipment failure data for many years. Seldom is the data analyzed in a scientific manner. Rarely do people acquiring the data see the data used to solve their problems. The net result is vast data banks of nearly useless information acquired haphazardly and annotated poorly. Today's task is to mine piles of existing data while acquiring new age-to-failure data in a carefully thought-out manner so it can be used for an economic advantage.

The engineering field of reliability offers many technical guidelines for how data should be acquired, annotated, and used for analysis. In many cases, failures need a "death certificate just as occurs with human failures. Death certificates for humans have been so productive in producing analyzable results, that it now illegal in the civilized world for a person to be buried without a death certificate listing age and cause of death. Reliability engineers are to failures in the industrial world as actuaries are to medical sciences and insurance worlds.

Humans profit from errors and experiences of various cultures in prolonging life by sharing data. In the industrial world, companies must benefit from the failure experiences of others because as individuals we simply cannot live long enough to acquire all of our own industrial failure data. We must compare our failure rates with other organizations and other databases for quantifying progress toward resolving problems in our company. Failure databases will be required within plants, within divisions, and within companies. Keep local data in Weibull databases (statistical) for competitive advantages. Share data in exponential form (arithmetic) for industry wide communication. Databases provide details for life-cycle costing by end-users to make better decisions about grades of equipment purchased and how failures affect long term operating costs.

Why not use failure data from suppliers? It's simple—they don't have much data, and end-users are unwilling to pay for them to acquire detailed information. Also supplier information shows superior results compared to actual details from plant operations. Plant failure data reflects bad results from both operator and maintenance problems—it reflects real world conditions and not the best results from supplier's catalogs.

Suppliers need plant failure data to understand how their products really perform in the field. Also they realistically need to know how they compare with their competitors. Large end-users can acquire more operating hours (and often more

Barringer & Associates, Inc., P.O. Box 3985, Humble, TX, Phone 281-852-6810, FAX 281-852-6810
http://www.barringer1.com hpaul@barringer1.com

failures) in one year than a supplier will ever acquire during the lifetime of most industrial organizations. Thus end-users failure details provide suppliers much needed numeric insight.
Failure data from components and subassemblies costs money to acquire, record, analyze, and store. Costs for replacements, labor, and expense for the wrench turners are recorded in minute details. However these costs are only the tip of the iceberg sinking the business. The biggest costs (lost margin) from failures is seldom recorded as a single detail because the numbers are not obvious and a monetary cause-consequence is not often recorded.

When the enterprise is sold out, the biggest failure cost number is associated with loss of the process to generate gross margin dollars—this is the hidden bottom of the iceberg. Total failure costs are required for justification of alternative actions and cost effective replacements. Of course if the enterprise is not sold out, then the cost of lost business caused by failures is much smaller. People within a plant are so busy with "doing" activities that an overview of the cost of **un**reliability is lost. Simple, graphical techniques are needed to get the attention of the organization. The key criterion for understanding plant reliability is the cost of **un**reliability. Building a simple Pareto distribution for the cost of **un**reliability is a real eye-opener for communicating to the organization the need for improvements to reduce failures (Barringer 1996).

One clue for optimizing reliability lies in life-cycle costs (LCC). The definition of life-cycle cost is the sum total of costs estimated to be incurred in design, development, production, operation, maintenance, support, and final disposition of a major system over its anticipated useful life span (DOE 1995). LCC is useful for trade-off and tracking studies to help find the lowest long-term cost of ownership by considering cost alternatives effecting system effectiveness. The system effectiveness equation joints LCC, reliability, availability, maintainability, and capability of equipment (Raheja 1991).

LCC analysis (SAE 1995) helps establish baselines for cost tracking and monitoring, identifying hardware or software elements with major costs, acts a decision criterion between competing designs, and provides estimates of end-user costs. LCC analysis applies to a variety of equipment from electrical, electronic, mechanical, and software controlled devices. The analysis can be moderately complicated to sophisticated including use of Monte Carlo models to gauge effects of cost uncertainty using a multi-disciplined teamwork approach. The issue is to find, up front, correct system combinations that minimize LCC.

Few people understand all LCC details. Most people understand the cost of **un**reliability, which is driven by a tally of failures and costs resulting from the failures. Of course the cost of unreliability is also a subset of LCC.

Optimizing reliability starts on the front end of the design process and works through to the LCC using failure data. Optimizing the cost of **un**reliability starts after plants are built and effectively reduces problems built into the system by considering trade-off in corrective actions.

So how do you begin the reliability optimization process? Start simple. Collect age-to-failure data and costs associated with the failures. Share failure data with your supplier partnerships. Use the data arithmetically, and gradually apply statistics to solve problems in the plant. Then use failure data to design more cost effective plants.

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