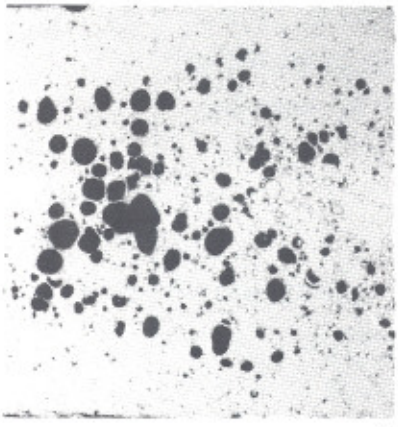
Nuts & Bolts

Published by NH Materials Lab

Volume 6, Winter 1997

Insightful Failure Analysis in 6 Steps



Swiss cheese? Not exactly. See "In Real Life."

In a manufacturing world filled with TQM teams and ISO-9000 audits, customers are demanding effective corrective actions. Around the coffee machine, part failure is blamed on misuse by the customer, or poor product assembly. Maybe, it's a lack of maintenance or design errors. A scientific analysis of the failure can get to the root cause of the problem and, usually, solve it for good.

Manufacturers and service providers from job shops to billion dollar multinationals have relied on scientists to identify the problem and recommend corrective actions. For many, the costs of the analysis are recovered in reduced warranty costs and greater customer satisfaction.

The investigative process is iterative. So, it is easy to proceed in routine steps (see below). This is a plus for the manufacturer who must determine if the cost of the analysis outweighs the cost of simply replacing the part. Proceeding in steps manages the cost of the investigation, while revealing key physical clues that may solve the problem forever.

Step 1: Gather Data & Samples

The pieces of the failed part must be collected and stored in a fashion that will avoid corrosion on the fracture surfaces. Never touch the fracture surfaces or fit them back together. These will damage the surfaces. Be sure to report the conditions of operation, details on the failure itself and background on the supplier and the part history. Knowledge of recent design changes can be especially helpful.

(Continued on page 2)

Inside:

"Man's mind (sic), once stretched by a new idea, never regains its original dimensions."
— Oliver Wendell Holmes

The failure analyst is the Sherlock Holmes of industry.

Step 2: Examine Visually

Once the background information is collected, the failed part is examined under low power magnification to determine the type of fracture. Fracture surfaces have "profiles" that are interpreted by an experienced analyst. When more detail is needed, a sample of the part may be prepared and examined under higher magnification to reveal anomalies in the material structure or on the fracture surface. Often this visual analysis provides conclusive results. However, sometimes more information is required.

Step 3: Prepare the Test Plan

The test plan defines the tests and conditions required to more fully evaluate the material. In most cases, the material is tested for conformance to the design specification. Failure to meet the specification is not necessarily the cause of failure.

Step 4: Analyze Sample

The materials are analyzed in accordance with the test plan. Routine tests include chemical analysis or mechanical testing for strength or hardness. If these results are not conclusive, testing under simulated conditions may be necessary.

Step 5: Test Under Simulated Conditions

It is always helpful to have an exemplar (a reference sample) available during the analysis of the failed part. Comparing "good" and "bad" parts can save both time and money. A "good" part can answer many of the questions generated in the analysis. It can also be used when "simulated conditions" testing is required.

Step 6: Present Conclusions & Recommendations

Once the analysis is complete, you will be presented with results and recommendations. Be sure the report includes the methods used to determine the cause of failure. The report should also include copies of any photographs or photomicrographs that were taken. These may be useful, if the problem is attributed to a customer or supplier part.

If you have any questions, please call us at **800-334-5432.**

"The clock, not the steam-engine,
is the key-machine of the industrial age."
— Lewis Mumford

Mechanical Testing: 101

The testing of mechanical properties is used to verify a material's conformance to a specification and to determine its suitability for load-bearing applications. Mechanical testing includes:

Test	Explanation/Benefit
Creep:	Measures the amount of deformation incurred under sustained loads. This is especially important in the application of plastic parts or metal parts in high temperature environments.
Elongation:*	% elongation provides insight on how well components of a machine will share the load. This is especially valuable in the design of multi-component structures.
Fatigue Testing:	Used to assess how well a part will sustain cyclic (dynamic) loading. This testing is recommended for many vehicle components and moving machine parts.
Hardness:	Material hardness correlates to wear resistance and is helpful in evaluating surface finish and coatings. Hardness testing is often performed as a QA step to check material strength and heat treatment.
Modulus of Elasticity:	Quantifies the stiffness of the material. This information helps in assessing the component's ability to share the load and resist deflection.
Tensile Strength:*	Determines how well a part resists breakage; it's the ultimate strength.
Toughness:	Indicates how well a part resists impact fracture. This measure also correlates with low cycle fatigue strength.
Yield Strength:*	Indicates the level of stress required to produce permanent distortion.

*These three data points are useful in checking conformance to design specifications. They are supplied from one test and results are often available in as little as 24 hours (when no machining is required). Call us for a quote, or to explore how this testing can help you. (800-334-5432)

In Real Life: It was a "Snap"

A major auto maker was having trouble with glove-box emblems which were breaking during installation.

The metal met specification, however, the casting itself was found to be extremely porous (see front photo). The porosity explained the "snapping" problem. However, there was another wrinkle.

The problem only occurred in parts which were cast on Mondays.

Here's what we found...

On Friday afternoons, the unused molten metal was left in a crucible. Over the weekend, it absorbed gas from the air. This made the casting porous.

The Solution...

We suggested that a protective chemical cover be applied to the molten metal for the weekend. This eliminated the absorption of gas, without impacting the metal.

Information Needed:

Who: _____
Title: _____
Company: _____
Address: _____
City, State, _____
Zip: _____
Phone:

____ *Call me, I have questions.*

____ *Send general info on Laboratory Services.*

____ *Send info on Failure Analysis.*

____ *Send info on Mechanical Testing.*

Complete this information & Fax it to: 603-692-4008

This issue features information on...

Failure Analysis

Call the Help Line
800-334-5432

- Laboratory Services
- Failure Analysis
- Application of Materials
- Mechanical Testing
- Corrosion ID
- Metallography
- Material ID & Certification
- Thermal Analysis
- Contamination ID

Nuts & Bolts by:
NH Materials Laboratory
22 Interstate Drive
Somersworth, NH 03878-1209

Address Correction Requested

A quarterly newsletter featuring solutions to manufacturing material & engineering problems.