By: CLIFF KNIGHT
Owner/President
KnightHawk Engineering

Forensics of data and information for industry investigations

How many times have you been faced with a design issue, troubleshooting problem or failure evaluation and there is just not enough data to solve the problem? Even though you feel you do not have enough data to push on, the problem must still be solved. Most of us are acquainted with the schoolbook test problem where all of the data is given to solve the problem. Then we graduated and went to work, and the problem solving became real sporty. How many times has your supervisor come to you with a problem and said, "Here is the problem, and here is the data you need to solve the problem"? So how do you attack a problem with limited data? There are several ways.

One way is to collect data through research. Another way is to take measurements. But what if it is a new design or the problem involves a failure investigation? Suppose you do not have time for research, and there is no way to take any measurements. The typical solution is to use good engineering judgment based on experience and charge forward, taking all available precautions to minimize any risk. While engineering judgment and experience are important to consider, there are analysis methods available to provide additional information. These are analysis methodologies that combine engineering experience with high-end technological approach to ensure a high probability of success to the design problem.

There are three basic technological approaches to solve a problem:

1. Absolute methodology — This analysis methodology calculates the exact solution to the problem based on the actual load condition. This analysis methodology is used widely in design with success primarily due to the safety factor built into the analysis to account for the intangibles. Good examples of this are vessel and heat exchanger design, turbine blade design and typical process design. Frequently, this approach is attempted in failure analysis and troubleshooting. But the problem is in the real world. We do not always know all of the scientific constraints of the problem or have high knowledge of the load conditions. The validity of the input data may be an issue for the actual real world problem. This methodology is often referred to as the "University Approach" and is buried in the acquisition of data by staff. Remember no analysis is any better than the input going into it.

2. Relative parameter methodology — In this situation, the engineer has some idea of the behavior of the physical system under a particular load. Examples are a measured deflection under a certain load, pressure drop in a process system under a particular flow-rate and turbine horse power under certain load conditions. A sensitivity study could be performed and an analysis method can be derived to predict the response based on a change in load. Also, a numerical model can be developed to incorporate all parameters, and the relative response will be accurate to the corresponding change in load. A variable sensitivity study is normally performed to understand what parameters have a remarkable effect on the solution. Frequently, sensitivity studies are performed with the only intent being to understand how either load or problem constraints affect the solution. This approach is powerful in eliminating sources of a problem. This methodology is often paramount in failure analysis and troubleshooting.

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3. Bracketed parameter methodology — This methodology also involves a sensitivity study of parameters. This methodology normally has nearly as much input data as absolute methodology with the exception of a few key parameters. A good example is the convective heat transfer film coefficient used as a boundary condition to determine the temperature distribution through a component.

A forensics of data and information is powerful in solving a problem. There are times when the data and information seem to be limited. Some might believe there is little information, and there may be a tendency to "shoot and hope" — that is just to repair or replace the part. The bottom line is the data you have is telling you something, and you just have to be willing to listen and use it. The best approach is to look at the data and characterize it.

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