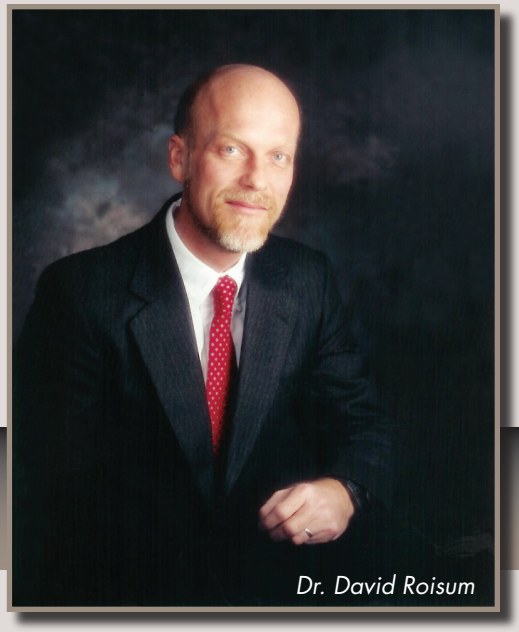
CRITICAL THINKING

by Dr. David Roisum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How Do You Define Machine Quality?

We are familiar with web quality. We know, for example, that average web thickness should be suitable for the customer's needs and conform to specs for that grade. Tolerable variations of thickness, whether min/max, standard deviation, or other measure, are equally important specifications for web quality. We could say the same for other web quality measures such as tensile strength, smoothness, color or chemistry, for example.

The concept of machine quality is not as clear. Just as with webs, we could define it as "fitness for duty." However precise the definition; it is not so useful in practice because it lacks quantitative detail. Just as with webs, we must specify a mean and allowable tolerance.

Let's start with an easy example, width. We would specify the machine to be capable of handling not only a typical width, but any width falling in a range between min/max as determined by the machine's owner. The allowable variation affects the design and performance of mechanical and control components.

The book on rollers

But what about the nuts and bolts of design—such as rollers, which are the building blocks of machinery? How "good" do rollers have to be? For that matter, what do we mean by "goodness"? Fortunately, we have answers to both of these questions, if you want to do a little homework. For example:

- rollers should be round (TIR and taper) and should be aligned,
- rollers should not bend or vibrate excessively,
- the web should not slip on rollers, and
- rollers should not load up the web so that tension control is lost, etc.

My textbook on the subject, The Mechanics of Rollers, (TAPPI Press) has a chapter on each aspect of roller "goodness" and suggests tolerances. These quality tolerances reflect the successful operation of countless thousands of machines built by scores of builders. They are based on experience. They are a field-proven compromise between inadequate quality and unjustified quality. These quality parameters could be written into purchasing specifications to protect the buyer from the occasional design that is not up to snuff and even save money from over-design.

As a rough rule of thumb, rollers should be accurate to around the thickness of a human hair by all measures. Some, like diameter variation on a hard nip, may need to be less, literally a fraction of a hair's breadth. Others, like alignment of rollers with tolerant materials such as textiles, may tolerate several hairs breadths of crookedness.

What about controls? Again, we can be guided by experience. The average tension should be able to cover the range between and agreed on minimum and maximum. Equally as important, the tension variation should not normally exceed 5-10 percent of setpoint, as read by responsive load cells (not filtered and displayed on a PLC). The same with nips. Nip load should cover the range, and variations should normally not exceed 10 percent of setpoint.

Implicit in these controls are some very important details. First, the correct units for web handling (strength, tension, nip and motor torque) are the same: lb/in. in the English system and kN/m in metrics. Second, the system must be independently calibratable, or else we could not be sure that we have the setpoint set at the value we think. Any system which does not include calibration procedures for analog should be refused. Third, we should be able to accurately measure variations. Load cells make this easy for tension. Nips can be similarly equipped. However, this may be unnecessarily costly. Instead, there are simple procedures that can measure variation indirectly without a load cell.

Buyer beware: Some machinery does not conform to good design (or maintenance) practice. To protect yourself, you merely need to write quantitative machine quality parameters into the purchasing specs and include a last payment penalty clause as an incentive.

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