A case study in Machine Effect

As tire uniformity machines age, most tire manufacturers rely on measuring the runout of both the upper and lower rims to calculate tooling compensation. Although rim runout plays a significant role in this process, other factors such as misalignment of the rims or orbiting of the spindle shaft also contribute to changes in force about the spindle. If left unaccounted for, these extra forces—which we call machine effect—can cause a level of non-repeatability in excess of the original machine's design tolerance. Too much machine effect can cause tires to be misgraded, or even cause otherwise good tires to become scrapped.

A problem identified

Machine effect becomes amplified when working with commercial vehicle tires. Every tire has an inherent springrate the amount of force that pushes back for each unit of distance the loadwheel presses into the tire. With truck tires, springrates higher than 5000 pounds per inch are common. This means that for every 0.001" of rim runout, the machine registers an additional 5 pounds of force that does not really exist on the tire.

During a recent test of a truck machine, CTI measured the individual radial runout of the top and bottom rims using a dial indicator (see **figure 1**). At the worst case, the runout of 0.0011" measured on the top rim corresponds to a non-repeatability of 5.5 lbf for a single tire, depending on that tire's angular orientation on the rims. While it is possible to use this waveform directly to improve tire results, this correction waveform only shows half of the picture. Machine effect is missing from this equation, and that additionally affects the tire measurement.

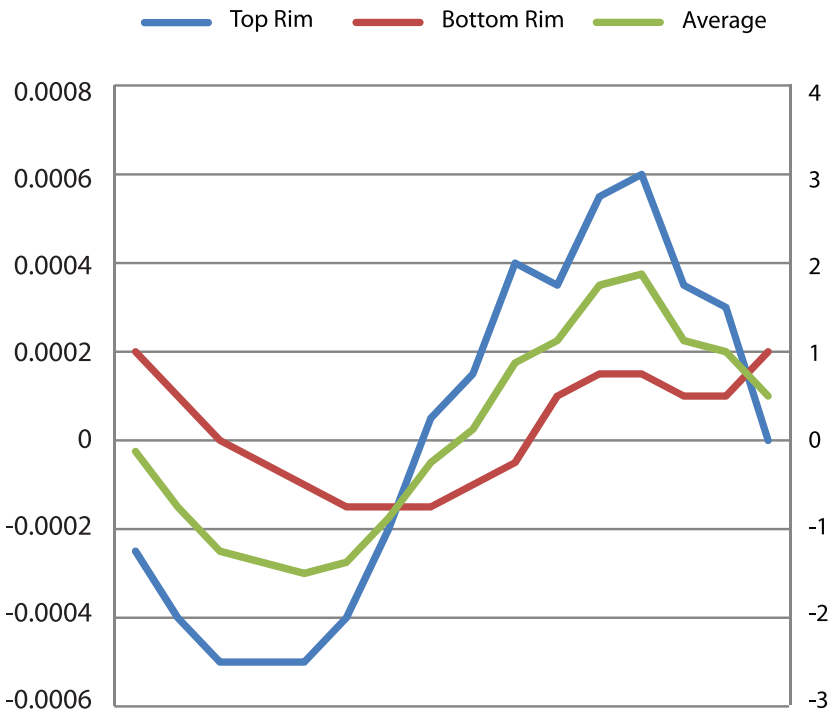

FIGURE 1 - Rim Runout Waveform

Our Solution

CTI's patented Spindle Characterization solves this problem by using the tire itself as the medium for calculating tooling compensation.

Using a single tire with a low Radial Force Peak-to-Peak (RPP) value, it is possible to calculate the total machine effect irrespective of the dial-indicated runout of the rims. By testing the same tire over and over again at different positions around the spindle (the more angles, the better), we can average out the tire's own waveform and be left with the original influence of the spindle itself.

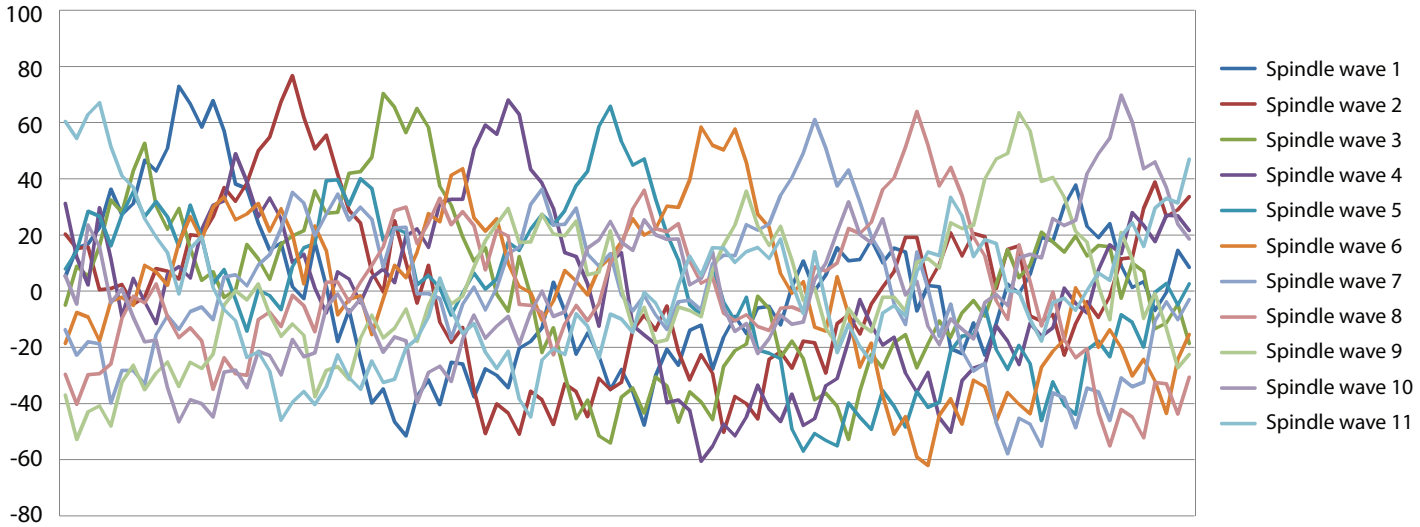

FIGURE 2 - Spindle Characterization Waveforms

In figure 2 above, a low-RPP truck tire is tested at eleven equidistant angles around the spindle under normal air pressure and load. The tire's highpoint is clearly visible, replicated across the circumference of the spindle. By averaging all waveforms together and applying special Fourier transforms to the data, we are left with the correction waveform (figure 3) that best fits the profile of the spindle.

Notice how this data differs from the graph in figure 1. It has the same overall shape, but the amplitude of the correction wave is at least twice the amplitude of the rim runout alone. Instead of relying on distance measurements to correct for force, we can use this new force correction wave directly to apply tooling compensation to all subsequent tires based on their own characteristic springrates.

The resulting data shows a sharp decrease in the Standard Deviation of measurement values after applying the Spindle Correction waveform during a 25-tire repeatability test (see figure 4 below). This remarkable difference allows a tire manufacturer to keep an aging machine in full operation until enough wear-and-tear finally warrants repair of the spindle.

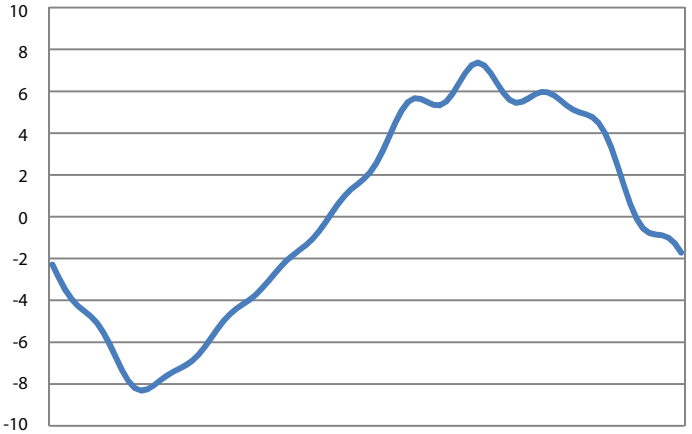

FIGURE 3 - Spindle Correction Waveform

	CCW			CW		
	RPP	RH1	RH2	RPP	RH1	RH2
Uncorrected (Original) Waveform	6.111	6.05	1.42	9.621	11.03	1.36
Loadwheel Characterization Applied	5.413	5.96	1.19	9.419	11.01	1.29
Spindle Characterization Applied	3.799	3.25	1.19	2.163	2.07	1.28

FIGURE 4
Standard Deviation of 25 tires (values in pounds)

Improve your bottom line

Using CTI's patented Spindle Characterization algorithm together with Loadwheel Characterization, tire testing has never been more accurate—even on older machines. Both Spindle and Loadwheel characterization come standard on all Poling Group machines with TTOC 6 controllers.