EDITORIAL

PRÜFTECHNIK

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APPLYING INERTIAL ROLL ALIGNMENT IN THE VACUUM METALIZING INDUSTRY

ABSTRACT

With exponential technological growth in the present day, it is no surprise that industrial advancements have reached the core of roll alignment throughout general manufacturing industries around the world. The PARALIGN®, with built-in inertial technology, was invented to counteract the limitations of traditional optical measuring systems. The ability to create shorter machine downtime is what pushed the PARALIGN® service to the forefront for roll parallelism projects allowing clients worldwide to increase uptime, production speed, and product characteristics. The following report is a detailed account of a vacuum metalizing company implementing PARALIGN® technology to measure the parallelism of rolls. During the five-hour PARALIGN® service, a total of thirty-three rolls were measured and of those, eight rolls were found to be askew. Misaligned rolls were properly adjusted according to the corresponding vertical and horizontal offsets determined by the PARALIGN® measurement method. Adjusted rolls were remeasured to find their final position. As a result, the PARALIGN® service was able to aid in making the necessary adjustments needed to correct misalignment and enhance overall quality of the product, while reducing the required downtime.

INTRODUCTION

The constant demand for high quality, mass-produced goods leaves manufacturers striving to optimize their machinery while simultaneously reducing production wastes, downtime, and upkeep costs. Machine maintenance is achieved through various combinations of diagnostic systems, measurement methods, installation and repair techniques, and quality controls. Roll alignment maintenance, in particular, is an essential starting point and good investment when improving a machine's overall functionality. Performing the alignment reduces the risk of uneven web coatings, excessive wastes, and premature roll and bearing wear.

In recent decades, the task of aligning rolls has heavily relied on optical measuring techniques such as telescopic transits, theodolites, and laser systems. Traditionally, alignment methods were performed by people looking through alignment telescopes and interpreting optical micrometers or dial indicators. Optical laser tools have provided a dependable means of utilizing a line of sight to establish precise reference lines and reference planes in order to determine roll parallelism. Optical measurement processes, however, can be hindered by a line-of-sight, atmospheric conditions, inaccessibility of the rolls, error propagation, and the time-consuming nature of the method itself. Rolls that are structurally separated, not visible to the operator and/or laser, or enclosed in ovens and vacuum chambers, for example, are virtually impossible to measure this way. It is common for vacuum metalizers to house rolls in enclosed chambers that are extremely difficult to measure optically, thus causing limitations of traditional methods.

Vacuum metalizers are responsible for adding value, enhancing appearance, and improving the range of application of products. The author of Vacuum Technology and Applications confirms, "In recent years, the market for vacuum metallized plastic films and papers has increased significantly" (Hucknall, 251). Sigma Technologies LLC, a supporting producer of vacuum metalized goods, specializes in using thin films and surface functionalization to manufacture low emissivity insulating fabrics and heat reflective films. The process consists of polymer films being coated with aluminum, copper, silver, and multi-layer optical filters to exhibit super-low emissivity values. The end product is used as an insulation alternative to save energy and prevent excessive heat transfer in architectural settings. According to the study Materials Science in Semiconductor Processing, "about 40% of heat losses in residential building and industrial facilities occur as a result of leakage through the transparent constructions (windows, balconies, etc.)" (373).

Earlier this year, Sigma Technologies located in Tucson, Arizona, identified unfavorable product issues that were believed to be caused by roll misalignment. Sigma operators often detected tracking of the web in their vacuum metalizer. There was an obvious need for an alignment procedure, but the enclosed nature of the machine caused many limitations for standard alignment technology. How can the rolls be measured accurately and in a timely manner?

The answer is inertial roll alignment technology recognized as the PARALIGN® method designed and developed by PRUFTECHNIK. The PARALIGN® device houses three ring-laser gyroscopes that are strategically placed perpendicular to one another in order to measure in the x,y, and z planes, respectively. The basic principle of operation is that a single ring-laser gyroscope can measure any rotation about its sensitive axis allowing the PARALIGN®'s orientation in space to be known at all times. The patented PARALIGN® software tracks each roll's center axis in space. The ring-laser gyroscopes possess high sensitivity and stability, quick reaction times, insensitivity to acceleration, and immunity to most environmental effects. Additionally, the same gyroscopes are actively used in military aircraft and space technology – giving the PARALIGN® its unique design and competitive edge.

Image 1.1:
2-Dimensional representation of the PARALIGN® and its three ring-laser gyroscopes positioned to measure x,y, and z planes

SOLUTION

The PARALIGN® technology, created by PARALIGN®, reinvents the way roll alignment maintenance has been performed in the general manufacturing industry for over hundreds of years. Its non-optical feature allows previously inaccessible rolls to be measured accurately in a fraction of the time required by traditional methods. Instead of measuring the rolls against a centerline or baseline, the PARALIGN determines the center axis of each roll, and then compares the center axes internally to a single reference roll. Typically, the reference roll is deemed the most critical roll in the process; one that is difficult to move or cannot be moved in a timely fashion. It is important to note that the reference roll can also be reassigned on the fly during the service with the click of a button in the patented PARALIGN® software.

In order to measure the parallelism of rolls, one technician holds the PARALIGN® device as it sweeps at least 20 degrees across the surface of each roll. Using the patented sweep mode method and Bluetooth technology, the second technician instructs the program on the laptop to start collecting data as the PARALIGN® moves along the roll face. While the PARALIGN® travels across the circumference of the roll, the software tracks points. When enough reliable points are collected, the second technician instructs the device to cease measuring. The amount of time needed to measure one roll is roughly 30 seconds. Internally, the software combines the points found along the roll surface with trigonometric equations to calculate the angle of the center axis of the roll. The angle is used in conjunction with the bearing-to-bearing length (in) of the roll to calculate its vertical and horizontal offset in relation to the chosen reference. The horizontal and vertical offsets are displayed instantly next to each roll as the measurements are collected. Figure 1 shows an example of the graphical image that is created as rolls are measured with the PARALIGN®.

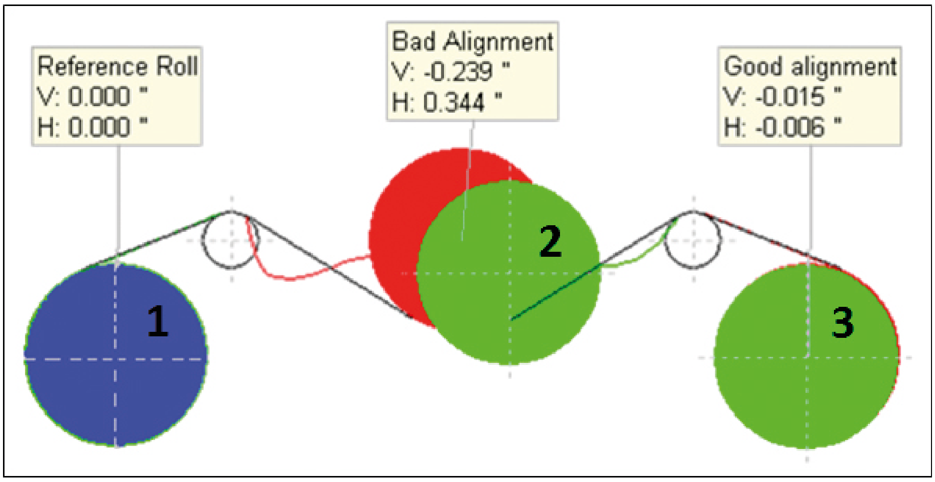

Figure 1.1:
Image displaying misalignment with corresponding vertical and horizontal offsets for 3 separate rolls in an arbitrary line

To interpret this image, the green circle represents the operator side of the roll, while the red circle represents the drive side of the roll. Looking into the page is the equivalent of looking through a machine from the operator side to the drive side. The reference roll (1) is indicated with the blue circle and is shown to have zeroed out vertical and horizontal values. Bagginess, stretching, and wrinkling are some of the typical signs that will indicate the misalignment as found in Figure 1.

The software automatically suggests the client may see bagginess on the drive side of the web between rolls 1 and 2, or bagginess on the operator side of the web between rolls 2 and 3.

Initially, an alignment tolerance is implemented by the client as a target parameter for the measured machine. If offsets outside of the tolerance are discovered and mechanics are available, technicians will remain onsite until corresponding adjustments are made.

The technicians recheck the adjusted rolls to verify the final resting position. A detailed written report and resultant initial and final images are distributed to the client within two to three business days. The significance of the images shows a complete overview of the initial status of the machine versus the final measurement schematics once the adjustments have been made. The written report includes notes about the service and provides a full account of the line(s) measured and the concluding outcome.

RESULTS

During the five-hour service, two technicians measured the parallelism of thirty-three rolls ranging from 114 to 134 inches. The client selected the Process Drum to be the reference roll for the entire machine; represented as the blue circle in the following figures. A target tolerance of 0.025" was selected by the client at the start of the service. Of the rolls that were measured, a total of eleven rolls were found to exceed the selected tolerance: two winders – one on either side of the Process Drum; Roll 2.13; and the eight rolls marked in purple boxes in Figure 2.1 – Figure 2.4 that were later adjusted during the service. The four bowed rollers, shown as clear circles in Figure 2.1 and 2.3, do not have consistent center axes across the surface of the rolls; and therefore, are not able to be measured with the PARALIGN®.

The exact movement of the rolls can be observed by comparing the horizontal and vertical offsets between the initial and final images: for the right side of the vacuum metalizer, compare Figure 2.1 and Figure 2.2. For the left side of the vacuum metalizer, compare Figure 2.3 and Figure 2.4. Also, consider that the positive (+) and negative (-) signs of the positions may change.

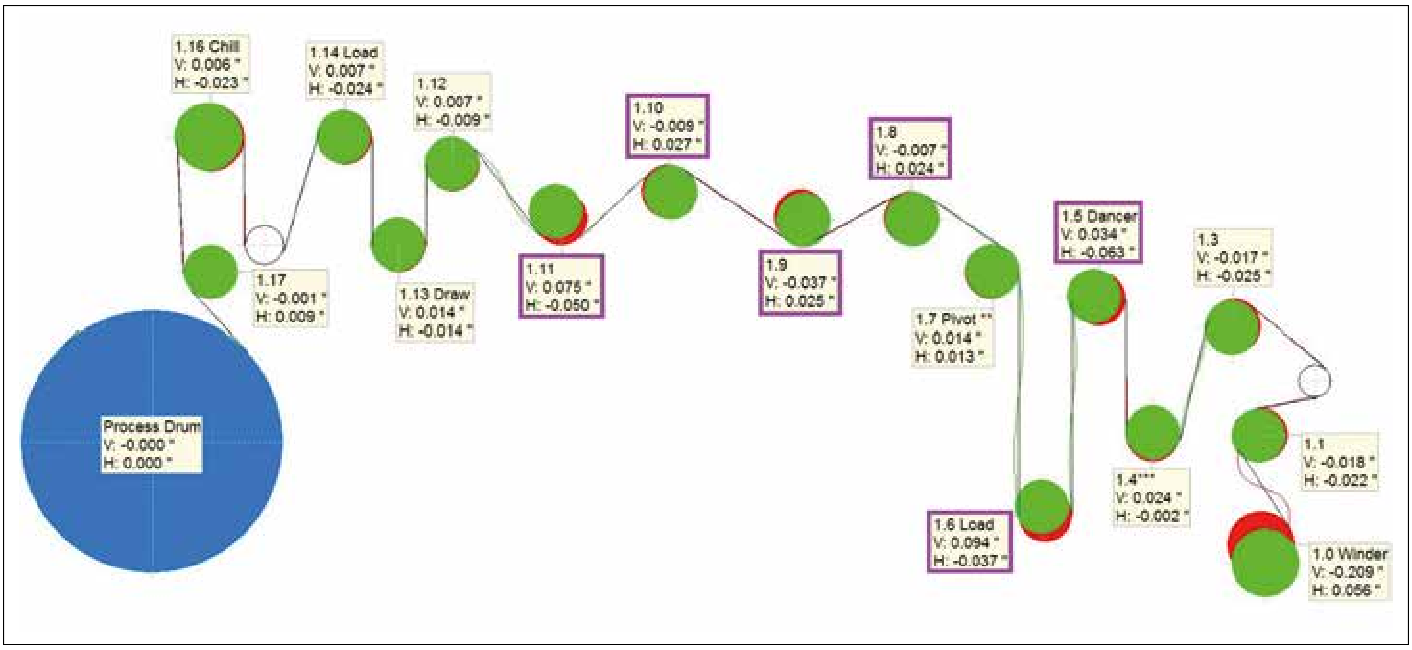

Figure 2.1: Graphical image displaying **initial** position of rolls to the right of the Process Drum (reference)

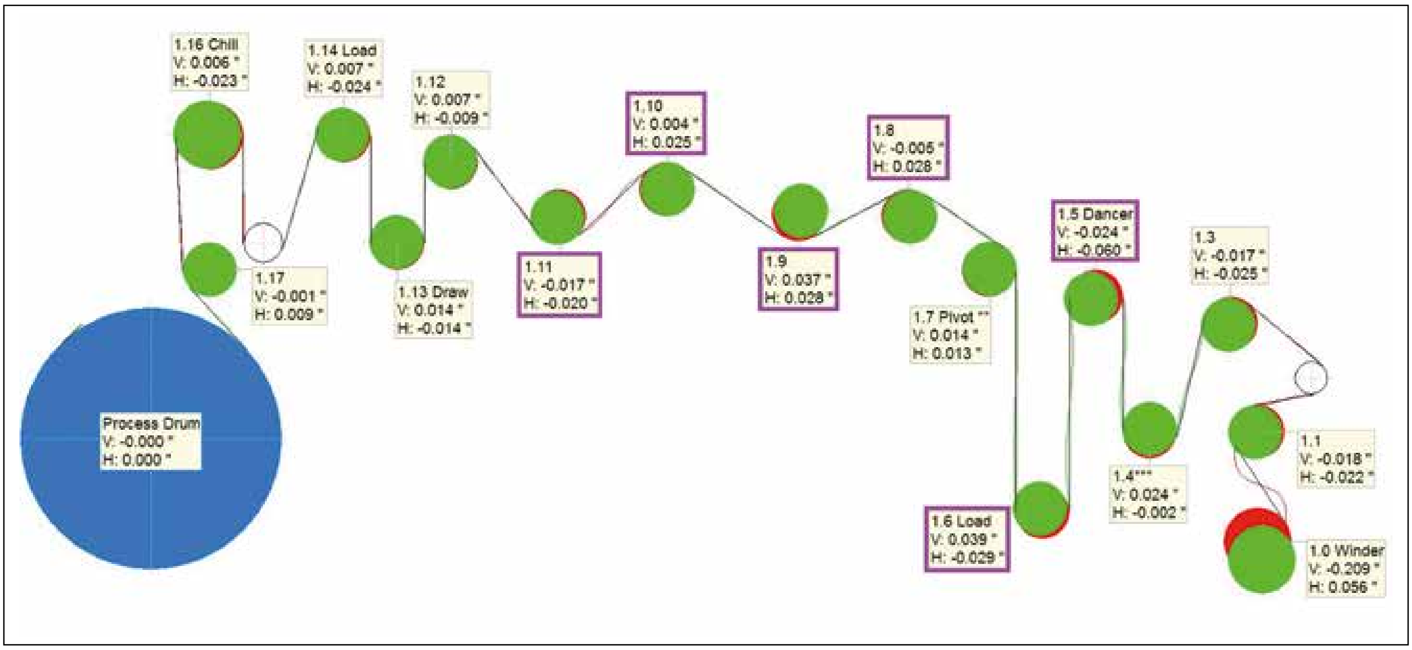

Figure 2.2: Graphical image displaying the **final** position of rolls to the right of the Process Drum (reference)

NOTE:

Adjustment to the 1.5 Dancer Roll was difficult to gauge since the roll independently moved and was not firmly bolted to the framework. Exact positioning of the roll may vary during production. Plans to stabilize the roll would correct the variable movement and would be performed in the future by the client.

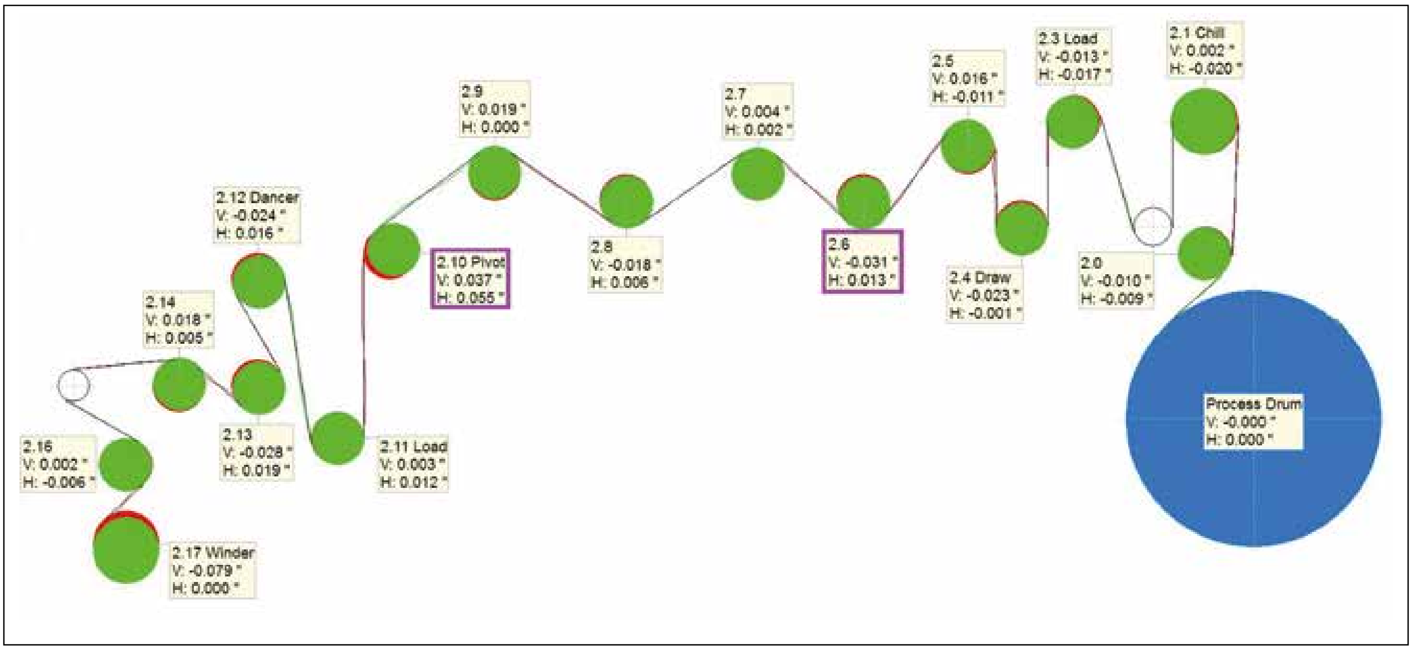

Figure 2.3: Graphical image displaying **initial** position of the rolls to the left of the Process Drum (reference)

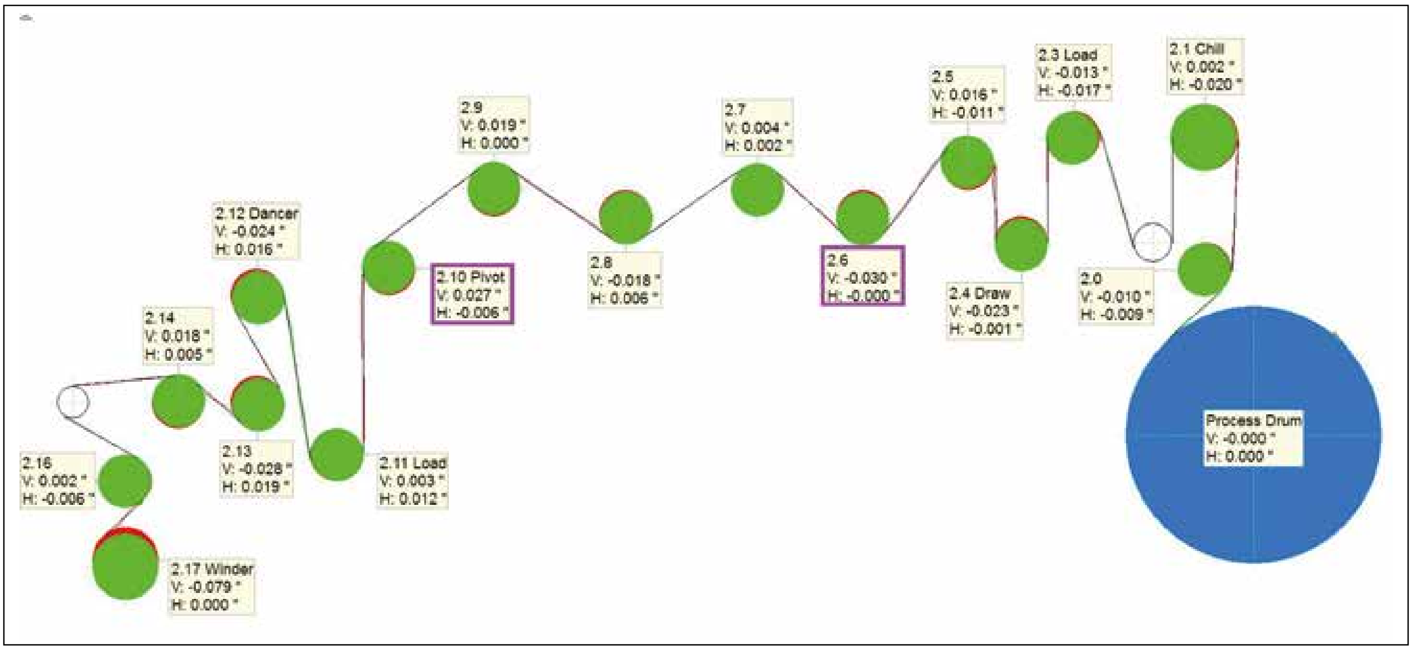

Figure 2.4: Graphical image displaying the **final** position of the rolls to the left of the Process Drum (reference)

Of the eleven misaligned rolls, the client chose to focus on adjusting the eight rolls outlined in purple boxes below. The winder on the right side of the vacuum metalizer was significantly misaligned to the reference roll. Although strategies to adjust such a substantial part of the machine were contemplated, it was decided that insufficient resources were available during the time of the service, and that adjustment to the winder would be carried out at a future date by the client. The technicians consulted with Sigma's in-house mechanics to support corresponding adjustments to the eight rolls.

Once the machine was back up and running, Sigma operators noticed an absolute difference in the behavior of the web path. Consequently, tracking was no longer an issue and product wastes were decreased. The adjustments made during the service optimized the machine's output as well as prevented excessive damage to the rolls and bearings.

CONCLUSION

Over time, rollers can become misaligned due to flimsy frames, loose mounts, web breaks, poor maintenance, improper machining or installation errors. Normal wear and tear on the rolls can also occur during the production phase. It is critical to identify roll misalignment at early stages in order to prevent unhealthy web characteristics, excessive bearing wear, and other mechanical failures.

Some of the limitations of the PARALIGN® include its inability to measure bowed rolls and soft rubber rolls. As previously mentioned, the center axis of a bowed roller will change as you move across the surface length of the roll; for that reason, bowed rolls are not able to be measured with the PARALIGN®. Rubber rolls less than 60 Shore D on the hardness scale are not able to be measured. The sensitivity of the device would recognize its own weight sinking into the soft rubber roll and yield an unreliable result.

Benefits of the PARALIGN® technology include decreased wastes, decreased downtime, and increased production speed and quality. The PARALIGN® is not only practical for use in the vacuum metalizing industry, but in fact, valuable in a variety of manufacturing industries such as: paper, plastic, printing, tire, metal, and film. Its creative design does not require a line of sight: subsequently location, elevation and proximity are not factors in the roll alignment process. Results are not dependent on user or atmospheric conditions. And finally, the rapid set-up and measurement time makes the PARALIGN® the ideal solution to measure roll parallelism.

Conclusively, roll alignment procedures no longer require lengthy shutdown periods to restore machine health. Previously hard to reach rolls are able to be measured quickly and accurately. Machine availability and product quality is increased to meet the customers' demands and standards. Ultimately, manufacturers can reduce their overall maintenance cost with routine alignment audits.

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About PRUFTECHNIK
The PRUFTECHNIK Group, with its subsidiaries and partners in more than 70 countries worldwide, continues to set new standards with innovative technological advancements in the field of machine alignment and vibration measurement technology in order to maximize and optimize the operational safety of machines and plants.

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