

Monitoring and Diagnostic Applications with Chordal Roll Micrometer Technology

William E. Mellander
Harford Industries, Inc.
Epac Division
1635 Starwood Drive
Chesterton, IN 46304

E-mail: Epac@harfordindustries.com

Thomas A. Weiler
Nucor Sheet Mill Group
Hot Mill Supervisor
4537 Nucor Road
Crawfordsville, IN 47933

E-mail: tweiler@ns-ind.com

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Introduction

Chordal based saddle type roll micrometers (Roll Mics) have made possible uses and applications that heretofore were not possible. These Skate Units are not simply roll profiling devices; they are diagnostic and management tools.

Background

The producers of flat rolled products are experiencing greater customer expectations in the areas of gauge tolerance, shape control and profile. Mill and roll manufacturers have responded with innovative technologies to help meet end user demands.

These technological developments have resulted in the necessity for mills and roll shops to review and rewrite their processes and procedures.

In addition to the need for roll shops to grind rolls more accurately, the mills, in order to calibrate the various mill control models, are requiring roll shops to provide feedback on issues such as worn roll profile, thermal profile and diameter reduction. This has been a significant challenge, as the information is most valuable if it can be obtained and supplied immediately after roll change, and ideally while rolls are still in the mill. These requirements have demanded a re-thinking of roll measurement technology. This paper addresses this challenge and presents a cost-effective, user-friendly solution.

The Solution

The answer is chordal technology which provides a skate unit (Roll Mic) that needs only 46° of arc exposure on a roll barrel rather than the 180° required with a caliper roll mic. Additionally, a chordal skate unit is so compact, light weight and rigid it does not have to ride on the top of a roll. Skates can be done on the side or even the bottom of a roll. Chordal units have the ability to read and record true roll diameter in addition to physical and thermal roll profile and taper in a single skate. This technology provides a Skate Unit that addresses and eliminates drawbacks inherent in caliper technology by providing a completely rigid unit that, except for the wheels and gauge head probes, has no moving parts. They are rugged precision instruments that can take abuse and still provide consistent, reliable performance in real life mill and roll shop environments. A Work Roll unit with a range of 14" to 38" weighs 11.0 pounds and

has a “saddle” measuring 6.75” X 8.25” with the chord arm extending out 8”. The Back-up Roll unit with a range of 36” to 64” weighs 14.5 pounds and has a “saddle” measuring 6.75” X 14.5” with the chord arm extending out 12”.

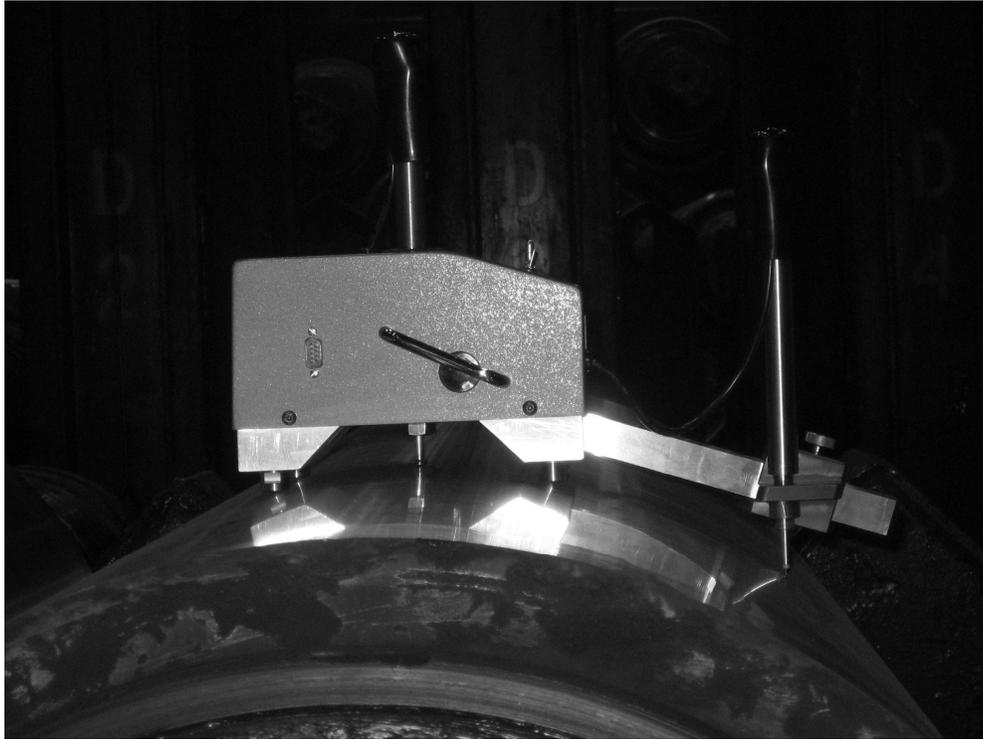


Figure 1: 14” to 38” Chordal Skate Unit Side View

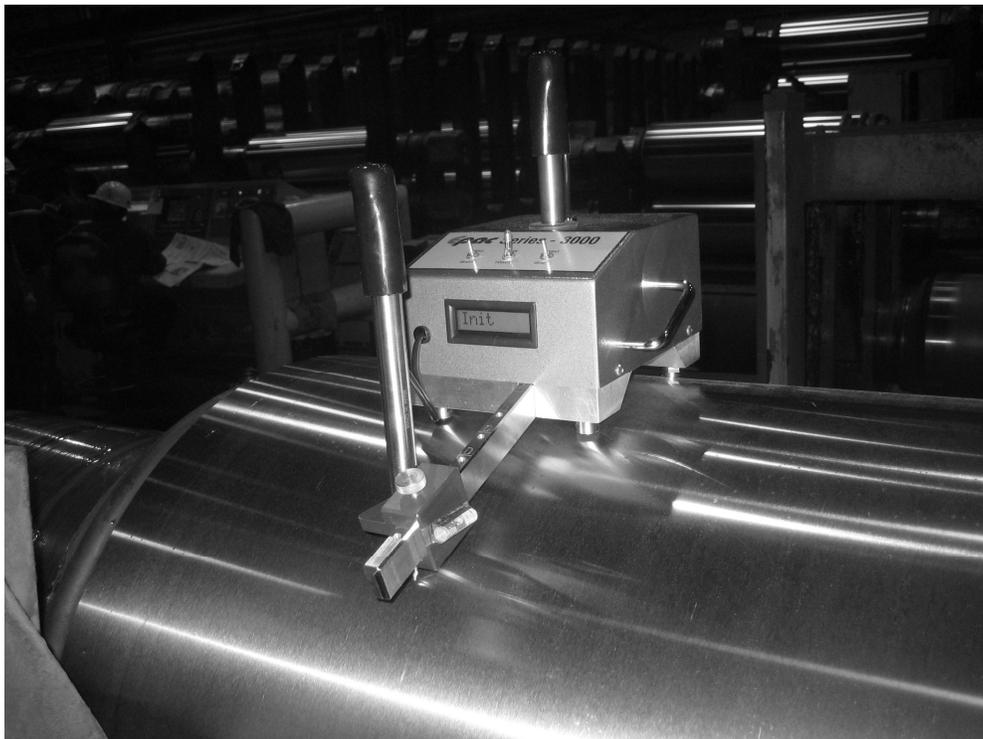


Figure 2: 14” to 38” Chordal Skate Unit Front Oblique View

Mill Monitoring and Diagnostic Applications

As new mill and roll innovations are phased in it is necessary to learn and understand what roll campaign life can be and what the rolls have been subjected to in a mill stand. During a downturn every critical roll on the line can be skated in place to assess the need for change. This is possible with chordal technology due to its size. Chordal skate units can do what other roll mics are not able to do. With this chordal technology and a regularly scheduled monitoring program mill performance can be analyzed and problems diagnosed. As a database is established abnormalities and inconsistencies will become apparent. The warning has been given that something is not right and corrective action needs to be taken before it develops into a major problem.

Some typical mill diagnostic applications made possible and presently in use with chordal e-mic technology are:

- Suspected “Thermal Bubbles” - Both the top and bottom rolls can be skated within minutes from the time that the stack is pulled. A full stack analysis takes about three minutes. The graphic display of the physical and thermal profiles together with the skate distance scale at the bottom of the graph will show whether the spray heads are functioning properly. Also, it is possible to make an estimate of their relative performance.
- Skate End Coiler rolls in place. This procedure was being performed with Pi Tape readings right, center and left, was required by the quality control department on a weekly basis and was very time consuming. A chordal skate unit does the work in less time with far less effort and significantly, provides complete roll profiles.
- Back-up rolls can be skated while still in their chocks with the tie bars in place to determine at the earliest possible point in a down turn process if a roll actually needs to be changed. Some mills have experimented with skating the backup rolls while they are still in the stand.
- Caster rolls skated in place to determine if in fact a particular roll needs to be changed.

Additional applications for the Chordal Roll Skate are the Mill rolls that can influence the strip shape, such as Coiler Pinch Rolls, Wrapper Rolls, Heavily wrapped idler rolls, etc. Some mills have developed skate schedules to determine wear rate of these and other rolls in order to improve the predictive maintenance of their mills.

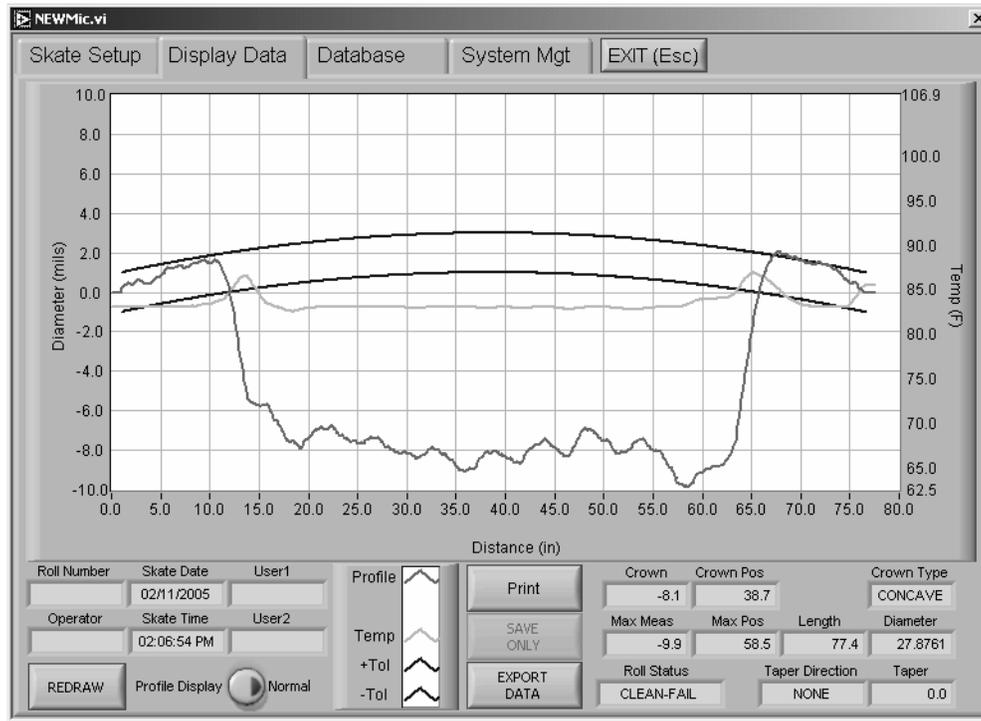
Work rolls reflect what they were exposed to and there is a direct correlation between the elapsed time after a stack is pulled and the quality, the usefulness, of the skate data. The data is knowledge and knowledge is power - The power to make informed decisions and answer these questions: What is the real campaign life of a particular roll? When does it need to be re-ground? Does this stack need to be stripped? If any of the work in question is being done unverified it is probable that roll life and labor are being wasted. Time is money and the savings are a source of significant cost reduction. Pennies per ton cannot be ignored.

Roll Monitoring and Diagnostic Applications

The practice of running “dirty” skates is very cost effective. This is especially true when phasing in “New generation” rolls or to compare rolls purchased from different manufacturers. Examples of the opportunity for savings lie in the following areas:

- The analysis of roll performance. This includes comparing rolls in terms of grade, manufacturer, products being processed, mill stands, and position of rolls in mill stands. Each and every one of these comparisons can provide insights that can yield opportunities for savings.
- Campaign life – If the rolls are checked before the roll stack is stripped and they are still within tolerance it makes no sense to strip, grind and rebuild them.

- The grinder operator needs to know the condition of the roll that he is going to grind.
- The thermal profile is in a range that will not affect the finish profile.
- Grind as needed, not by SOP procedures that reduce roll life by taking off “X” mils before generating the desired profile.



**Figure 3: Dirty Skate Graphic Display Showing:
Tolerance Bands at +/- 0.001”
Thermal Profile at 83° F to 87° F
Physical Profile with 0.010” Wear Pattern**

The fact that “clean” skates are run is assumed. Some, if not all, roll grinding machines have profiling calipers but the need for verifying the results should be considered. Chordal skate units can do this plus the following:

- Provide a true diameter reading independent of operator “Touch and feel”.
- Provide a thermal profile to indicate if “Hogging” off high spots will affect the finish profile of rolls after temperature normalization.

Management Applications

The Epac Series 3000 supporting software is designed for simplicity of operation in offering a variety of display options: Auto Scale or Fixed Scale, English or Metric, 0.001” or 0.0001” Resolution, Graphic display as a function of radius or diameter and Display Leveling. The Database has sort capability by six different criteria in either ascending or descending order. As a stand alone system it is a powerful management tool to track roll life, roll performance, grinder performance, operator performance and, by recording diameter, roll order lead time. A number of these options were written to support ideas and applications that users and potential users saw in the capabilities and possibilities inherent in this new technology. The software processes, displays and stores Series 3000 data. When the database is downloaded to a base station the information is then instantly available to all interested parties and departments.

With the export data feature it is possible to transfer skates to a base station PC and overlay skates from each phase in the refinish process, e.g. Mill Condition, Finish Grind, Etching. This provides a complete graphic display of changes through each step: cause, effect and result.

Integration with Roll Shop Management Systems

Currently, Harford Industries is working to integrate The Series 3000 data into a seamless Roll Shop Management System (RQM) as follows:

Integrated Roll Quality Management System

The real power of this system will be seen when it is integrated into a company's existing Roll Management System, creating a Roll Quality Management system. The Series 3000 software supports interfacing to a company's Roll Management System. Several benefits emerge from integrating the standalone Series 3000 software into a company's RQM system.

Validation of Roll Identity

Integrating the data into an RQM System enables direct control of the roll identity. This allows the operator to enter the roll identity in only one place, the company's RQM system. When the skate data is collected in the standalone system an operator might erroneously enter a roll identity which does not match the company's identity system. With control of the roll identity, it will be validated as both a conforming identity as well as a valid roll with the proper status.

Validation of Target Crown, Tolerance and Conformance

The integrated data in a RQM System allows direct control of the target crown and tolerance. This enables the company to send its target and tolerance numbers for the crown directly into the system. Again this will allow the operator to enter the data in only one place, minimizing the possibility of data entry errors.

Data Upload Into Company's RQM system

Once the skate is complete and the data is sent back to the company's RQM system, the information can be logged and merged into one coherent record of the roll reduction that took place. A Roll Quality Management report and chart can be produced that records the reduction taken on the roll and its conformance to the standards set for the product for which the roll was ground. The roll diameter and crown returned can be used to automatically set up the mill for the rolling schedule.

Key Property Conformance

The data contains several of the key roll properties required by Statistical Process Control systems – profile, diameter, and temperature – and returns this information to a central location for conformance checking. A Statistical Process Control system requires data to check conformance of key properties of a roll to the intended use.

Process Troubleshooting

The data collected is then available for troubleshooting the process of creating an acceptable roll and for troubleshooting the process in which the roll is used. First, the data will assist the Roll Shop in producing an "acceptable" (conformant) roll for use on the mill. Secondly, if there is a shape problem on the mill and changing a roll fixes it, the Roll Quality Management chart can be evaluated and the crowning practices analyzed. Once this data is integrated into a central database with the mill data, the possibilities of analysis become infinite.

Financial Analysis

Once accurate roll reduction data is in a repository merged with mill data, a prediction of the life of each roll in the system can be made. Knowing the cost of the roll, original diameter, current diameter, scrap diameter, and average roll reduction for roll type, position, and crowning will allow a calculation to be made that forecasts the life of this roll. If this calculation is performed on every roll, and a required inventory level of roll type is known, then an RQM system could indicate how many rolls to purchase and when to maintain these roll inventory levels.

Benefits

The design breakthrough with this new technology has resulted in an instrument that is clearly superior to and provides dramatic benefits when compared to the old caliper designs. The Series 3000 chordal skate units are compact, lightweight, multi-tasking Roll Mics that are rigid, rugged and reliable. Independent R&R testing has been performed in working roll shops to compare these units with Caliper Micrometers (C-Mics), and Pi Tapes. The results of these tests show a significant gap with regard to the actual and perceived performance of C-Mics and Pi Tapes. Using different people, with the resultant variation in feel, touch and degree of attention, accuracy in practice is far from being assured. The Series 3000 is consistent. Head to head testing of the Series 3000 against other Electronic Roll Mics has proven the new technology's size, weight, accuracy and rigidity advantages. With the supporting software it is a powerful management tool that will store, sort and transfer the data that is critical to the operation and auditing of a roll shop. It will support the mill with set-up data and roll campaign critiques.

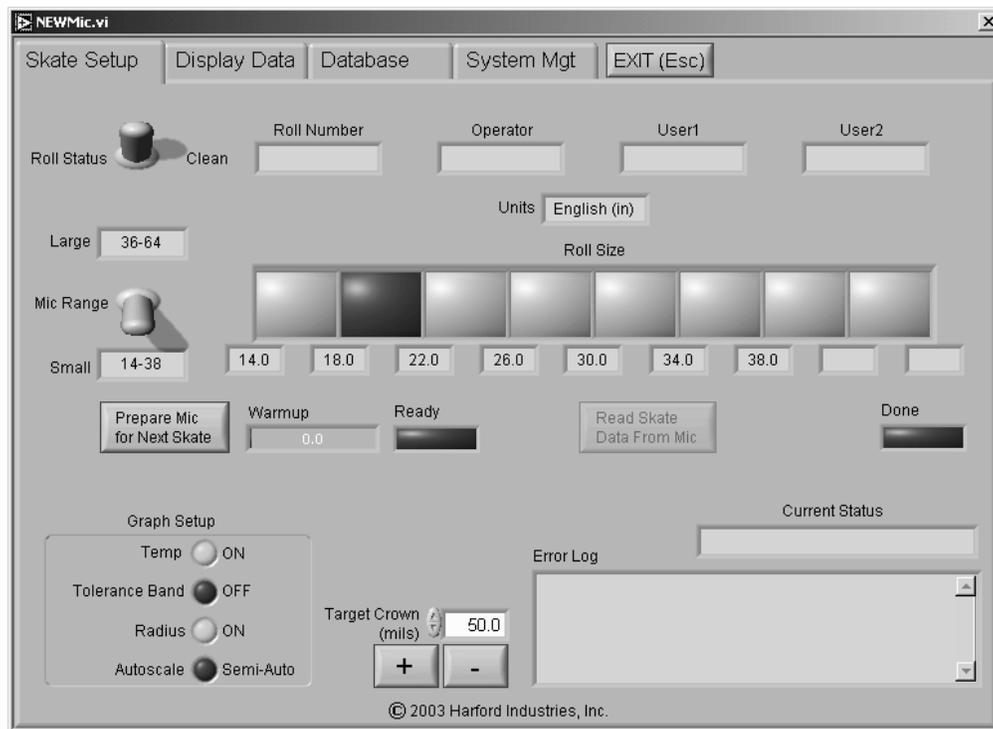


Figure 4: Skate Setup Screen

Summary

The technological innovations that Harford Industries has developed and is developing have been and are driven by the needs of the steel industry - Their short term and long term goals to meet and exceed customer demand. Working with and listening to the people that are responsible for achieving these goals requires "thinking outside of the box". Anything and everything is possible. The requirement is to produce the best technology available within a price structure that is cost effective.

Acknowledgments

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