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Product Design to Improve the Measurement and Projection of Mill Liner Wear †

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Abstract: Currently, in the grinding areas of Peruvian mining operations, there are linings made of various materials such as rubber and steel, all of which have a limited lifespan and eventually wear out. Understanding the wear behavior of these linings has a direct impact on mill performance. There are several solutions for measuring wear, making wear projections, and, most importantly, knowing the replacement date so that the mining company can schedule a plant shutdown. However, these solutions are not swift, as traveling to the mine, returning to the company, processing the data in software, and generating reports take 3 to 10 days depending on the workload of each supplier of these linings. Mining companies seek solutions to monitor the condition of their linings and avoid plant shutdowns as they disrupt production. The primary objective of this tool is to quickly and accurately predict the wear and removal of mill linings with user safety as a top priority. The product design and development process followed the methodology proposed by Ulrich and Eppinger, which includes (a) identifying customer needs, (b) planning, (c) developing product concepts, (d) system-level design, (e) detailed design, and (f) testing and refinement. Key metrics for design were defined through 50 surveys. Additionally, two focus groups with mill lining experts and user testing were conducted, allowing for the refinement and validation of the initial concept. The tool prototype was modeled in 3D, sensors and other electrical mechanisms were purchased, and an LED screen was programmed for data reading. Methodologies such as TRIZ, SCAMPER, and Canva were incorporated, facilitating a well-designed product with attention to detail. Finally, the final characteristics of the digital comb, ranging from 10′ to 25′, were defined and tested on mill linings, and with the help of the Weir Projection application, wear history and projections were rapidly generated. When compared with other measurement tools, minimal differences were found within a range of ±2 mm. Therefore, it is concluded that the prototype assists in quickly scheduling mill lining requirements in advance.

Keywords: mill lining; mining; wear measurements; plant shutdowns; product design; grinding

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1. Introduction

The mining industry in Peru plays a crucial role in the country's economy, serving as one of the primary sectors for generating income and employment. Mineral processing stands as an essential phase in the mining production chain, where resources extracted from mines undergo various processes to obtain valuable metals utilized across a wide array of industries [1].

Mineral processing in Peruvian mines entails a series of stages from initial extraction to obtaining high-quality concentrates or final products. This process encompasses diverse operations, such as grinding, which is crucial for its ability to transform large mineral blocks into smaller particles, thereby facilitating the liberation of valuable components, such as precious metals or industrial minerals, from impurities. This operation is carried out using specialized equipment such as ball mills, rod mills, or SAG mills, which apply mechanical forces to fragment the material [2].

These mills are internally protected by steel or rubber linings; these linings are designed to protect and improve the efficiency of the mills and are key to prolonging the equipment's lifespan and ensuring optimal performance.

The importance of understanding, controlling wear, measuring, projecting, planning for replacement, and the lifespan of these linings in mills efficiently and quickly is a critical task that mining companies are still seeking to address.

The research problem focuses on finding a solution that allows for the quick, precise, and safe assessment of the state of the linings, facilitating the timely scheduling of their replacement and thus avoiding unplanned interruptions in mining production. Furthermore, having rapid and precise solutions to assess the state of the linings will enable more efficient resource management and better planning of maintenance activities. Lastly, user safety, knowing the state of the linings, is crucial for preventing potential workplace hazards or incidents in the mining environment.

Controlling and monitoring the wear of linings in mills has led to the development of various research projects in the Peruvian and global contexts, all aimed at finding a system or model to estimate lining wear, which is a critical element for the proper functioning of a mill.

Below are some studies conducted in Table 1.

Table 1. Investigations relating to the control and monitoring of liners.

Investigation	Technology Type	Document	Scope
"Optimization of the cylinder liners' lifecycle in an 8′ × 10′ ball mill—2000 TMSD" [3]	Manufacturing of liners	Undergraduate Thesis—National University of Engineering—2014	Showcased the alloy and chemical composition change in the liners, successfully extending their lifespan.
"Optimization of maintenance during liner replacement in the Fuller mill at Southern Peru Company—Toquepala—2015" [4]	Reliability-centered maintenance	Undergraduate Thesis—National University of the Altiplano—2015	Analyzed the company's system; subsequently, with knowledge and data collection, developed the codification of liner criticality, enabling reliability-centered maintenance.
"Design and simulation of a manipulator for steel liners applied in conventional mills" [5]	Automation	Undergraduate Thesis—National University of the Altiplano—2018	Successfully optimized mill maintenance by reducing liner changes and operational costs.
"Mathematical model for estimating the lifespan of liners in semi-autogenous mills" [6]	Mathematical model	Undergraduate Thesis—Austral University of Chile—2015	Design and development of a mathematical model, utilizing descriptive statistics and programmable algorithms, to estimate the lifespan of liners.

Own elaboration based on [3–6].

These investigations have demonstrated that there is still a clear need to address the operational issues or failures that can arise from the malfunction of liners. The current research is based on the theoretical and ideal concept of the operation of conventional mills, proposing control models using measurement tools, statistics, and maintenance, which do not accurately adjust to the actual wear and lifespan of the liners.

Historically, it has been shown that all mining units apply various methods for the control and replacement of mill liners. These criteria range from a simple statistical model based on reliability to the use of costly and technologically advanced 3D scanners. Theoretically, the liner is replaced once they have reached the maximum allowable wear.

Our study aims to design a tool that allows us to assess the condition of mill liners, approximate lifespan, and estimate replacement time.

2. Methodology

We employed the Ulrich and Eppinger methodology [2] for the prototype of our mill liner monitoring tool. The process included needs identification, concept generation and selection, system development, and iterative testing, ensuring a design tailored to mining operational needs.

2.1. Planning

2.1.1. General Objective

- To design a tool that allows us to assess the condition of mill liners and estimate the approximate replacement time.

2.1.2. Specific Objectives

- Manage timely replacement and procurement of liners.
- Reduce unplanned plant shutdowns in mining companies.

2.1.3. Target Audience

The product is designed for mill liner suppliers with after-sales service (tracking the lifespan of their products) and for planning departments of mining companies that have milling equipment in their process flow diagrams.

2.1.4. Companies Offering Solutions

Several companies and consulting firms specialize in conducting mill wear reports and liner analysis in the mining industry. These companies offer services for the monitoring, evaluation, and optimization of mill liners to enhance equipment efficiency and lifespan.

2.2. Concept Development

To understand our design concept, we proposed conducting a survey with questions covering the size, weight, usefulness, functions, and shape for the tool to be designed.

Eleven initial questions were developed, which were later validated by an expert engineer specializing in the measurement and reporting of mill liner wear. The engineer suggested modifications, and it was considered pertinent to include an additional question concerning the compatibility of the readings projected by the prototype. Below are the final questions in Tables 2 and 3.

Table 2. Final survey questions for experts.

N°	Items	Interpretation of Questions
1	How long does it take you to generate a report on mill liner wear once you have obtained the information?	To determine the time required to generate a mill liner wear and projection report.
2	How long does it take you to gather on-site information?	To establish the time spent inside the mill taking measurements.
3	How many people assist you in gathering information to assess wear measurements?	To ascertain the number of individuals involved in taking measurements inside the mill.
4	Does the client request immediate information once you finish taking measurements?	To understand whether the client requests information immediately.
5	How soon does the client request information?	To determine the maximum number of days the client needs to estimate the next inspection or replacement of mill liners.
6	What is the precision of your measurement tool?	To assess the precision of the current measurement tool in use.
7	What tool do you use for taking measurements?	To identify the typical tool utilized.
8	What measurements are typically included in the mill report?	To gather information on the dimensions of the mill typically visited to define the prototype measurement.
9	How often are plant shutdowns scheduled to inspect wear?	To determine the frequency of mine visits for mill liner inspections.
10	What is the approximate weight of the current measurement tool?	To estimate the approximate weight required to define the prototype.
11	How much would you be willing to pay for a tool that provides instant measurement and wear projection?	To approximate the potential cost of our prototype.
12	Would you like the projections and graphs generated by the tool to be viewable and projectable with AutoCAD?	To determine if engineers require projections to be saved or utilized in the company's standard format.

Own elaboration.

Table 3. Final question survey results.

N°	Items	Interpretation of Results
1	How long does it take you to generate a report on a mill liner wear once you have obtained the information?	53.1% of the surveyed engineers take more than a week to complete a report because they have to return to Lima to process the data.
2	How long does it take you to gather on-site information?	50% of the surveyed engineers take between 30 min to 1 h because they take measurements of different parts of the mill.
3	How many people assist you in gathering information to assess wear measurements?	50% of the surveyed engineers indicate that 3 people enter the mill for inspection.
4	Does the client request immediate information once you finish taking measurements?	87.5% of the surveyed engineers indicate that the client requests information upon leaving the mill.
5	How soon does the client request information?	71.9% of the surveyed engineers stated that the client requests their wear report within 4 to 5 days at most.
6	What is the precision of your measurement tool?	65.6% of the surveyed engineers indicate that the margin of error of their tool is $\pm$5 mm.
7	What tool do you use for taking measurements?	87.5% of the surveyed engineers indicate that the most used tool is the Faro Focus 3D Scanner, followed by manual measurement (winches and vernier), and finally the manual comb.
8	What measurements are typically included in the mill report?	71.9% of the surveyed engineers indicate that the mills with the most inspections are of diameter 10 to 25 feet.
9	How often are plant shutdowns scheduled to inspect wear?	59.4% of the surveyed engineers indicate that they travel to the mine every 3 months for mill inspection during plant shutdown.
10	What is the approximate weight of the current measurement tool?	40.6% of the surveyed engineers indicate that their measurement tool weighs between 10 and 20 kg.
11	How much would you be willing to pay for a tool that provides instant measurement and wear projection?	59.4% of the surveyed engineers indicate that they would pay between $2000.00 to $5000.00 for a tool with instant wear projection.
12	Would you like the projections and graphs generated by the tool to be viewable and projectable with AutoCAD?	90.6% of the surveyed engineers indicate that they need the tool results to be compatible with AutoCAD.

Own elaboration.

After obtaining the results, it was decided to design a tool with the following characteristics:

- Instantaneous projection of current lining dimensions.
- Agile data capture process to reduce exposure time within the mill.
- Individual operation tool with exclusive access to information.
- Ability to generate a basic report immediately after data capture.
- Precision in measurements taken.
- Adequate measurement capacity for mill linings with diameters of 10 to 25 feet.
- Ergonomic and lightweight design to allow for single-user operation.
- Economical solution compared to 3D tools.
- Compatible for export to AutoCAD.

A brainstorming session was conducted to propose ideas for the design of the prototype, and it was decided to perform a reverse engineering of the manual comb (Figure 1), which is one of the tools that was initially used but gradually fell out of favor with the introduction of 3D scanners (Figure 2).

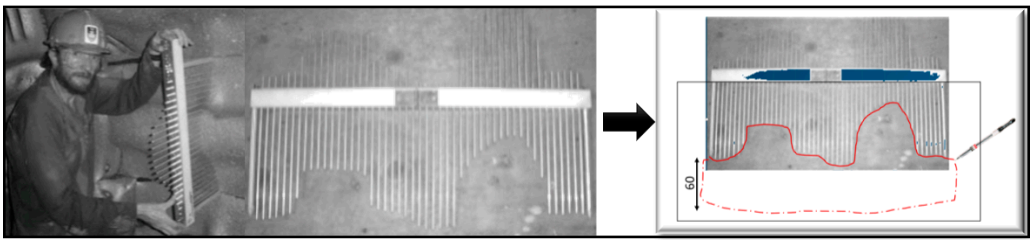


Figure 1. Measurement of linings with manual comb.

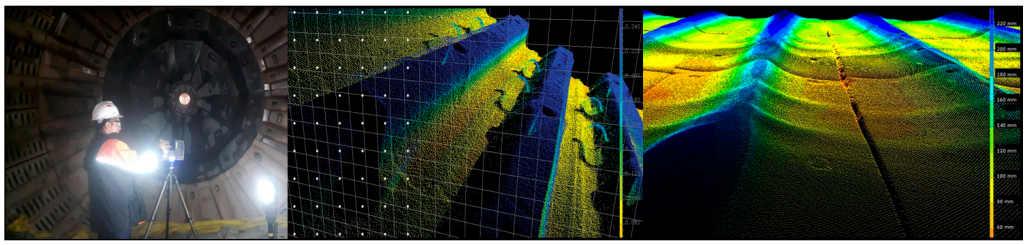


Figure 2. Measurement of linings with 3D scanner.

Sketches were made to adapt the use of the manual comb to a fast, precise and modern way with some type of distance sensor that allows knowing the measurements.

2.3. System Level Design

The manual comb is a homemade tool used to measure or obtain a fingerprint of the wear profile of the lining in ball and SAG mills. Each time the rods are closed, a profile is obtained, allowing for the creation of a database of lifespan over time to better predict the next lining replacement job or monitor improvements in lining design. However, these measurements or projections are not precise as each closing tip of the tool must be traced with a marker and projections must be completed manually, which takes a certain amount of time and reduces the accuracy of the actual dimension (Figure 1).

Based on this manual measurement method, it was proposed to install a sensor at each closing tip of the rods that can be measured or referenced to generate the worn profile. These profiles would then be transmitted to a built-in LED screen in the prototype for display and analysis.

No sensors were found that could transmit their own location among them and be programmed on a mini screen. Additionally, a prototype model with 29 rods (Figures 3 and 4)

was manufactured with a width of 300 mm. It was observed that maneuvering all the rods took a long time, and the precision in adjusting these rods caused problems when placing them over the worn liner.

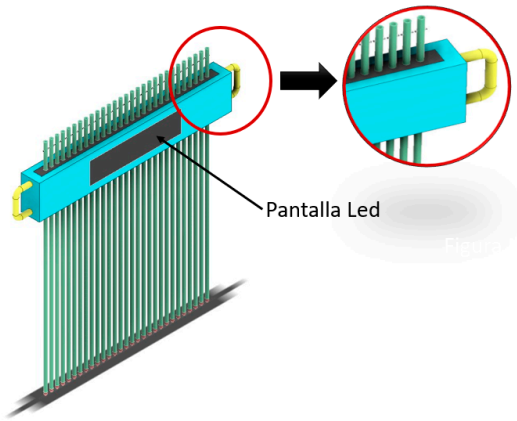


Figure 3. Three-dimensional (3D) sketch of proposed tool.

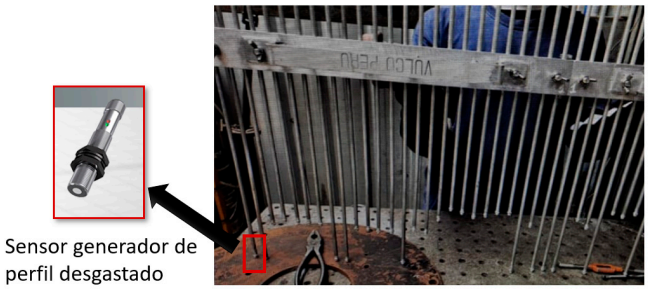


Figure 4. Manufacture of a tool with sensors on the tips for testing.

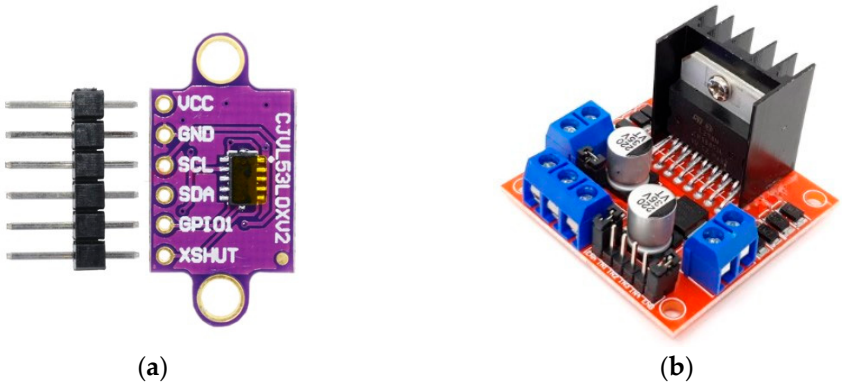
A subsequent proposal was made, which consisted of maintaining the design of the manual comb but incorporating the following main components:

Motion sensor: A single sensor capable of moving across the width of the worn coating and capturing the wear profile. The selected distance sensor was the ToF VL53L0X, a laser distance sensor that uses time-of-flight (ToF) measurement, with a measuring range of up to 2 m (Figure 5a).

Characteristics:

- Sensor: VL53L0X;
- Operating Voltage: 2.6 V to 5.5 V;
- Power Consumption: 10 mA (average current, may vary depending on configuration or environment);
- Maximum Distance Range: 200 cm;
- Accuracy: ± 1 mm;
- Interface: I2C;
- Size: $0.5'' \times 7''$.

Motor Driver L298N: Capable of moving the ToF VL53L0X sensor across the width of the coating, it is a high-power motor driver perfect for driving DC motors and stepper motors. It is commonly used to control motors and also has an integrated 5 V regulator that can supply power to an external circuit. It can control up to 4 DC motors or 2 DC motors with direction and speed control (Figure 5b).



(**a**) (**b**)

Figure 5. Main components for second digital comb proposal: (**a**) VL53L0X laser distance sensor; (**b**) Motor Driver L298N.

2.4. Detail Design

The ToF VL53L0X sensor was programmed using an Arduino, and LABVIEW graphical programming was used to visualize the generated graph. A gear motor and a Motor Driver L298N were implemented to control the speed at which the sensor would move (Figure 6).

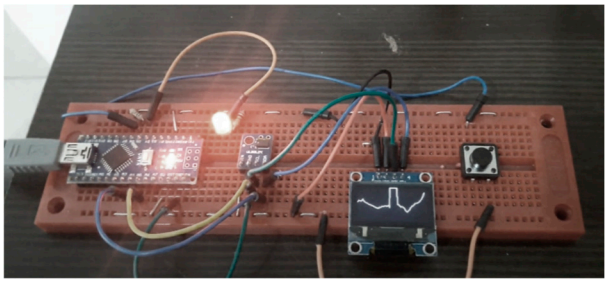


Figure 6. Programming of sensor and motor components for measurement tests on mini-screen.

Additionally, a 12V battery was installed to power the Arduino, which will supply voltage to the motor. All these components were installed inside a rectangular box that features a channel-like hole at the bottom through which the sensor will take readings of the worn coating (Figure 6).

The digital comb comprises two aluminum rods at the ends of the rectangular box; these rods each have a rubber foot to aid in positioning on the worn lining inside the mill. These rods are vertically adjustable and are secured with butterfly nuts that press against the rectangular box (Figure 7).

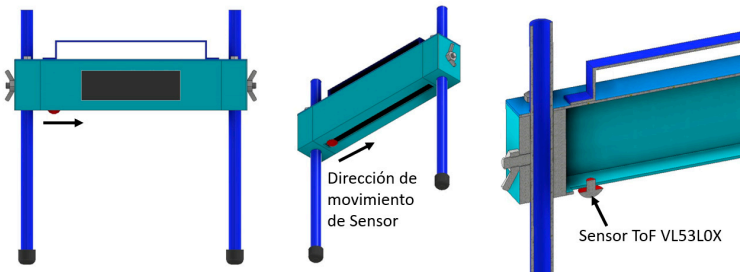
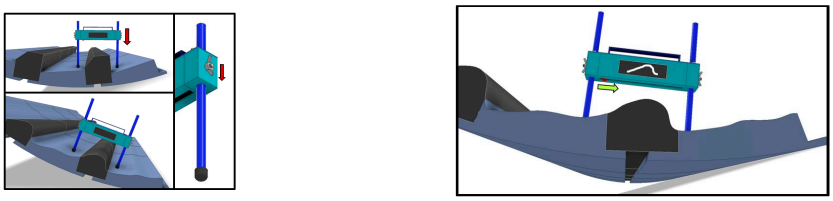


Figure 7. The digital comb isometric views.

2.5. Testing and Refinement

Three-dimensional (3D) simulations were conducted using Autodesk Inventor 2022 software to assess the positioning of the digital comb with various types of worn mill liners

ranging from 10′ to 15′ in diameter, demonstrating that the tool dimensions are optimal for the types of liners that the engineers surveyed inspect most frequently (Figures 8 and 9).



(**a**) (**b**)

Figure 8. Tool simulation in Autodesk Inventor 2021 design program: (**a**) positioning of rods on worn coating; (**b**) simulation of ToF sensor VL53L0X reading.

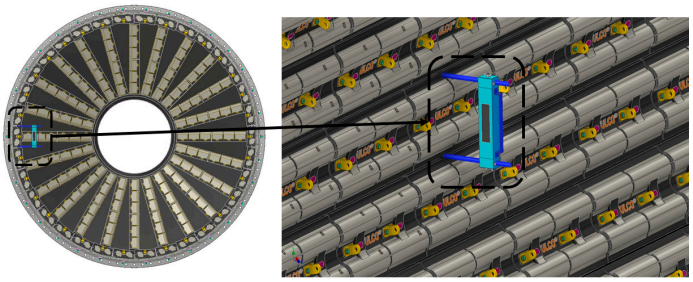


Figure 9. Digital comb simulation on mill liners Ø14.5′ × 23.5′.

Once the simulations were finished, detailed assembly drawings were initiated for the tool's fabrication. The materials for the rectangular box and positioning rods were specified as aluminum 6061 T6 to reduce weight and enable single-user manipulation. Subsequently, the electrical components were assembled into the rectangular box, resulting in a total weight of 3.5 kg.

Following assembly, tests were conducted to measure the accuracy of the ToF VL53L0X sensor in motion and at inclinations, as there is insufficient illumination and time within the mill. Fifty measurements were taken on the same liner, and the actual or nominal measurements compared to those taken with the moving sensor yielded an average deviation of ±3 mm. This precision margin is deemed acceptable for mill liners, as they are not machined elements, and in accordance with mill liner removal guidelines, they are typically removed with a remaining thickness of 20 ± 5 mm.

This liner profile could be visualized on the integrated screen at the front of the rectangular box. Prior to this, a reference measurement of the liner (remaining height of the plate-type liner) was taken and entered into the LABVIEW program. In this manner, the liner profile measurements were obtained.

The objective of being able to quickly and accurately capture the profile of a liner has been achieved. These measurements were visible on the screen and could also be exported to the AutoCAD program. Once the worn profile was imported into the CAD program, a wear history could be generated from the installation date to the removal date. It was considered that further benefits could still be realized to assist the inspection personnel in obtaining quicker responses and projecting wear curves and approximate removal dates using wear ratios (mm/day) obtained during each inspection.

A focus group was conducted with 8 experienced engineers in mill liner measurement and inspection in mining. During this presentation, the proposal for the digital comb was well received by the engineers. They appreciated the tests conducted and the achieved scope of the tool, as it would assist them in easily, quickly, and accurately measuring field dimensions. Brainstorming sessions were held on how to project wear curves and approximate removal dates to generate mini wear reports, meeting the mine clients' requests to

plan plant shutdowns with a future view of liner wear. The TRIZ methodology (Table 4) was utilized to generate new ideas and innovative solutions to continue improving the current tool. Through TRIZ, it was proposed to create an application capable of reading measurements taken by the digital comb, which could rapidly generate wear curves and projections of mill liner lifespan.

Table 4. Preparation of TRIZ methodology.

Phase	Description
Definition of the problem	Currently, there are no practical tools or alternatives that provide rapid and accurate wear reports to assess the state and wear projection of mill liners during a plant shutdown.
Analysis of the contradiction	Technical Contradiction: The need to obtain wear projections in graphs and tables through an application versus the need for a comprehensive and detailed report on the condition of the liners. Physical Contradiction: The fragility of a practical tool versus potentially being less than that of a current tool.
Using TRIZ principles	Modularity Principle: Removable parts for easy and safe transportation to the mine. Quick disassembly.
Solution selection	Designing a prototype with an incorporated sensor capable of measuring distances on the X–Y axes of the liners.
Solution implementation	To enable measurement, a motor is incorporated to move the sensor across the width of the liner.
Evaluation and improvement	Evaluation: Tests will be conducted to calibrate the sensor measurements. Projected wear curves are also simulated on the screen installed in the digital comb. Improvement: An application is added to visualize wear curves and projections on a mobile phone without the need to access the mill.

Own elaboration.

Once the idea of creating an application that works hand in hand with the digital comb was defined, the SCAMPER technique was used to generate new ideas about the application, services, and further improvement of the tool. Thanks to the SCAMPER technique, the solutions that the application would generate and the impact it would have on users were conceptualized (Table 5).

Table 5. SCAMPER elaboration.

Phase	Digital Comb for Measuring Mill Linings
Replace	Sensors: 29 position and measurement sensors. Sensors: 1 laser sensor that moves across the width of the liner.
Combine	The old design of the manual comb with sensor technology.
Fit	The visualization of wear curves and projections on a cellphone through an application.
Modify	29 aluminum tubes are replaced by only 2 tubes used for positioning the prototype.
Purpose or Properties	Additional uses: It can measure and project lifespan.
Eliminate	The interior rubber for tube grip is removed.
Re fix or revert	Welding points are modified for stoppage by butterfly nuts at the ends. The wear visualization is changed from a mini-screen integrated into the tool to a visualization on a mobile device with important data and images of the state of the liners.

Own elaboration.

The assistance of a programmer–designer of applications was sought, the main and secondary objectives of this tool were explained, and they managed to design the interface of the application named “Wear Projection”.

3. Results

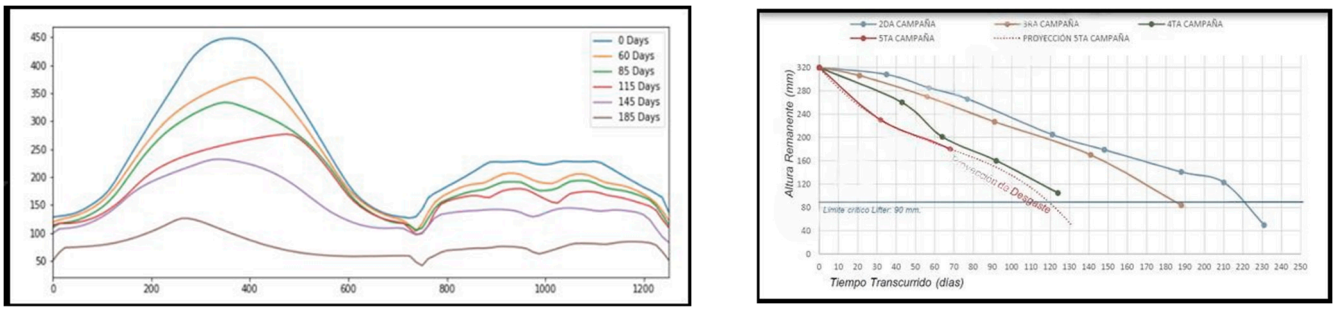
The final design of the digital comb tool for mill liners ranging from Ø10′ to 25′ has been defined. Below are the final metrics in Table 6.

Table 6. Final metrics chart.

N°.	Metrics	Unit	Value
1	Total weights	Kg.	3.5
2	Maximum measuring width	mm.	350
3	Maximum measuring height	mm.	400
4	Sensor measurement accuracy	mm.	±3
5	Screen size (width by height)	mm.	200 × 60
6	Motor Driver L298N	und.	1
7	Comb size (height × length × width)	mm.	515 × 505 × 75
8	Power button	und.	1
9	Adjustment and positioning nut.	und.	2

Own elaboration.

This tool was tested for mill liners of a size Ø14.5′ × 23.5′, and the measurements were transmitted to an Android phone via Bluetooth, where the "Wear Projection" application had been previously installed. This application rapidly generated the wear history for each inspection date of the liners (Figure 10a) and projections of wear and removal of lifters and plates based on wear ratios in mm/day (Figure 10b).



(**a**) (**b**)

Figure 10. Information generated by the "Weir Projection" application following the measurement of mill liners with the digital comb: (**a**) mill liner wear profile from installation date to removal date; (**b**) wear and removal projections based on remaining height vs. elapsed time.

Following the completion of tests on worn liners measured at various dates, the results met expectations. The tool stood out for its simple, precise, secure, and rapid measurement-taking process. Moreover, these measurements could be easily shared via WhatsApp or corporate emails with end-users at the mine site using only a cellphone.

Based on the results from simulations and measurement tests obtained on the mill liners, a comparison was conducted with other measurement tools to conclude the final stage. These differences were minimal with a variation of ±2 mm. at some points of the worn liner. Based on these findings, the effective control and monitoring of an entire campaign of liners for a Ø14.5′ × 23.5′ Ball Mill were achieved. The client was able to receive wear reports within the requested time frame, enabling proper planning for the next liner purchase and avoiding an emergency plant shutdown for the ball mill.

4. Conclusions

The digital comb displays wear projections and the approximate removal time of mill liners in a shorter time compared to current tools. This efficiency is facilitated by the "Weir Projection" application, which automatically generates the necessary information in a user-friendly and objective manner for the end customer at the mine site.

The digital comb aids in scheduling mill liner requirements in advance. By knowing the removal date or lifespan of the liners in the mills, efficient purchasing for the next change or replacement can be anticipated. It is considered that liner suppliers typically require 2 to 3 months to manufacture liners from the time the purchase order is received from the client.

The digital comb reduces the number of unplanned plant shutdowns due to mill liners by providing reliable data on the remaining liner thickness. This enables the efficient scheduling of maintenance and inspections for these equipment.

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References

1. Expomina 2023. Available online: https://expominaperu.com/ (accessed on 25 October 2023).
2. Improvement System in the Management of Plant Mining Processes (Crushing and Grinding). Available online: https://www.scribd.com/document/463123126/Sistema-de-mejora-en-la-gestion-de-los-procesos (accessed on 2 November 2023).
3. Optimizing the Life Cycle of Cylinder Liners in a 2000TMSD 8′x10 Ball Mill. Available online: https://alicia.concytec.gob.pe/vufind/Record/UUNI_bc54a5eaa21d4cc3eeb7dd06cd46185e (accessed on 2 November 2023).
4. Optimization of Maintenance in the Change of Linings in the Fuller Mill of the Company 88 Southern Peru—Toquepala. Available online: https://repositorioslatinoamericanos.uchile.cl/handle/2250/3277665 (accessed on 2 November 2023).
5. Design and Simulation of Manipulator for Steel Linings Applied in Conventional Mills. Available online: https://repositorioslatinoamericanos.uchile.cl/handle/2250/9371477 (accessed on 2 November 2023).
6. Mathematical Model for Estimating the Useful Life of Linings in Semi-Autogenous Mills. Available online: http://cybertesis.uach.cl/tesis/uach/2006/bmfcia773m/doc/bmfcia773m.pdf (accessed on 2 November 2023).

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