

Computer Vision-based Slab Profiling System for Optimizing Yield and Minimizing Defects in Plate Mill at Bhilai Steel Plant

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STEEL AUTHORITY OF INDIA LIMITED

स्टील अथॉरिटी ऑफ इंडिया लिमिटेड



- **Maharatna, Central Public Sector Enterprises (CPSE) is India's largest steel producer**
- **20.497 MT of Hot Metal and 19.239 MT of Crude Steel production**
- **Annual Turnover (FY) 2023-24 : Rs 1,064,453 million**
- **5 Integrated Steel plants, 3 Special Steel Plants**

Integrated Steel Plants

BSP



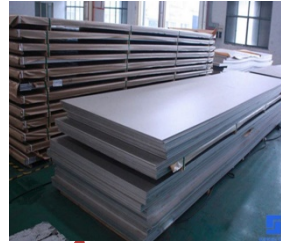
**Rails
(13/26m),
Long Rails,
(65-260m),
Blooms,
Billets, Slabs,
Channels,
Joists, Angles,
TMT Rebars,
Wire Rods,
Crane Rails,
Plates, Pig
iron & Coal
Chemicals.**

DSP



**Blooms,
Billets, Joists,
Narrow Slabs,
Channels,
Angles, TMT
Rebars,
Wheels &
Axles, Pig iron
& Coal
Chemicals**

RSP



**Plate Mill
Plates, HR
Plates, HR Coils,
Slabs, CR Sheet/
Coil, Galvanised
Sheets (plain &
Corrugated),
ERW Pipes,
Spiral Weld
pipes, CRNO,
Pig iron & Coal
Chemicals**

BSL



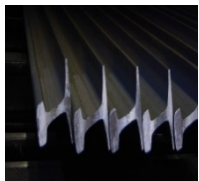
**HR Coils, Slabs,
HR Sheets.
Plates, CR Coils.
Sheets, GP
Sheets. coils,
GC Sheets,
Galvanealed
Steel, HRPO, Pig
iron & Coal
Chemicals**

ISP



**Wire rods, Bars
& Rebars, Joists,
Channels,
Angles, Blooms,
Billets,
Universal &
Special section
(Z-bar, MS
Arch), Pig iron &
Coal Chemicals**

Bhilai Steel Plant



- India's largest producer and supplier of world-class rails for the Indian Railways, including the world's longest 130-metre single-piece rails and 260-metre long rail welded panels.
- largest producer of wide and heavy steel plates and structural steel, catering to a variety of infrastructure projects across the country
- The plant specializes in the production of TMT Bars and Rods, all of which are earthquake-resistant and known for their superior quality
- The product range also includes wire rods, heavy structurals, including channels and beams, designed to meet the most stringent standards of modern construction

BSP - Plate Mill



- Capacity : 1.2 Mtpa
- Input material : comprises of slabs sourced from SMS2, which are rolled in to plates on Make to Order basis (chemistry, profile and mechanical property wise).
- Slabs are produced as per planned slab design for each size and TDC of plates (as per norm of PPC).
- Finished plates with thickness ranges from 8mm to 63mm, widths ranging from 1200mm to 3400mm and length up to 30meters

BSP - Plate Mill



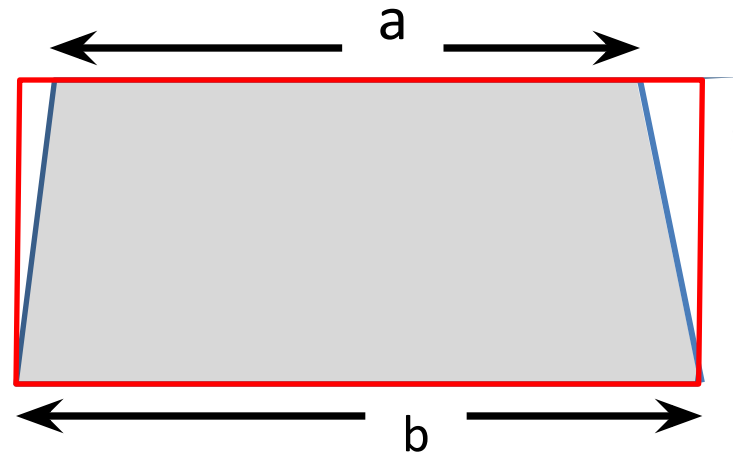
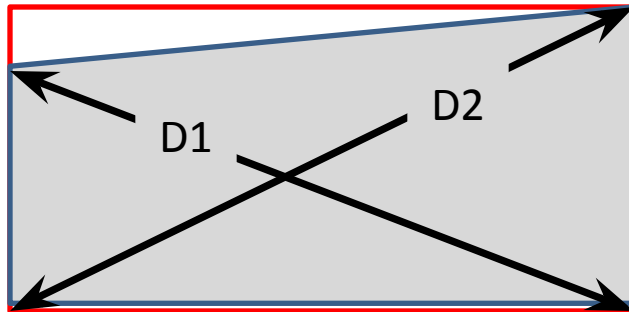
- To prepare heats as well as input profile of slabs to be accurate so that after taking into considerations of all allowances & loss (Scale & Scarfing) maximum yield is achieved
- Further, in order to get correct/actual weight of the slabs one slab weighing machine has been installed at charging side roll table before Reheating furnace.
- Rolling of plates is carried as per the rolling programme provided by PPC based on the actual weight of slabs to achieve maximum yield and reduce any wastage.

BSP - Plate Mill

Generally incorrect slab profile are of two types

- ❑ Taper cutting of the slabs ($D1-D2 > 50\text{mm}$)
- ❑ Slab Profile is not rectangular rather Trapezium or Rhombus Shapes ($a-b > 35\text{mm}$).

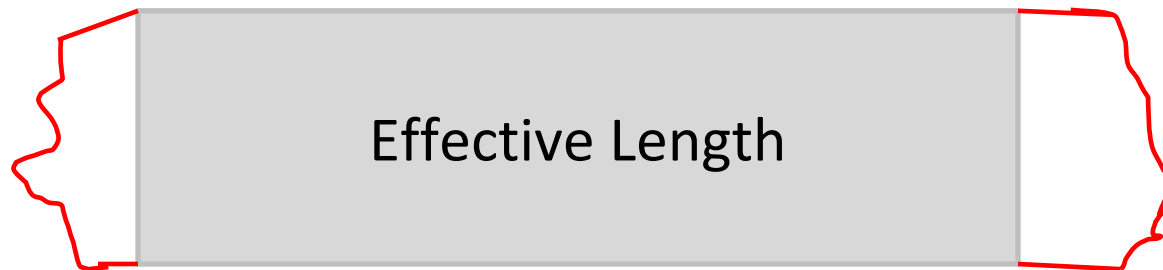
Above bad profile of slabs lead to more end cutting and defect generations as well as more scrap generations despite the fact that actual slab weight is well within specified range.



BSP - Plate Mill

Loss of order length

- ☐ End cutting of rolled plates has increased due to skewness/non rectangularity in the input slabs
- ☐ Due to excess crop which is a result of bad /uneven shape at the ends .
- ☐ In course of backward interpolation, the generation of bad crop and non-rectangularity of the plates has a strong correlation with the shape and ends of input slabs.



BSP - Plate Mill

Effects of skewness / non rectangularity of input slabs

- ✓ **Increased Cobble Generation** – Irregular slab shapes can lead to process disruptions, increasing the risk of cobble formation.
- ✓ **Reduced Yield Efficiency** – Material wastage occurs due to improper slab alignment, leading to lower overall yield.
- ✓ **Order Non-Conformity** – Skewed slabs may not meet the required specifications, resulting in rejected or reworked orders.
- ✓ **Decline in Customer Satisfaction** – Quality deviations can lead to delays, inconsistencies, and dissatisfaction among customers.
- ✓ **Resource Wastage** – Inefficiencies in processing lead to unnecessary consumption of time, energy, and financial resources.

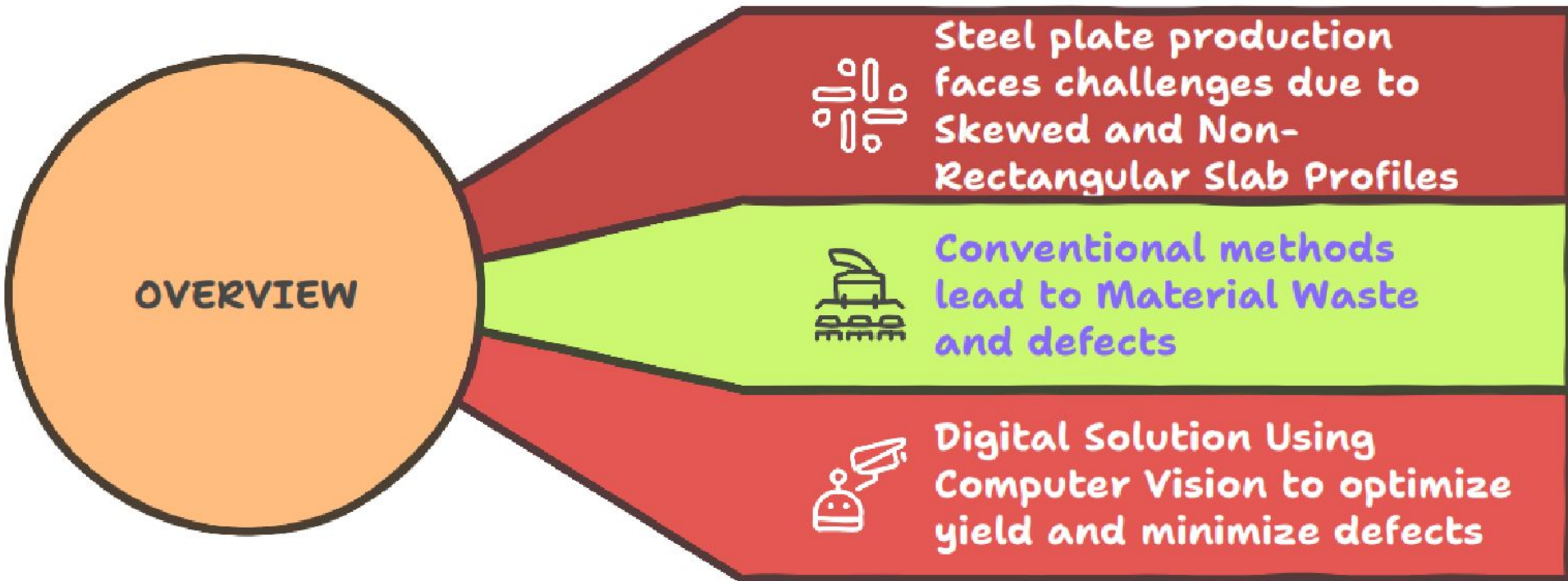


Project Title

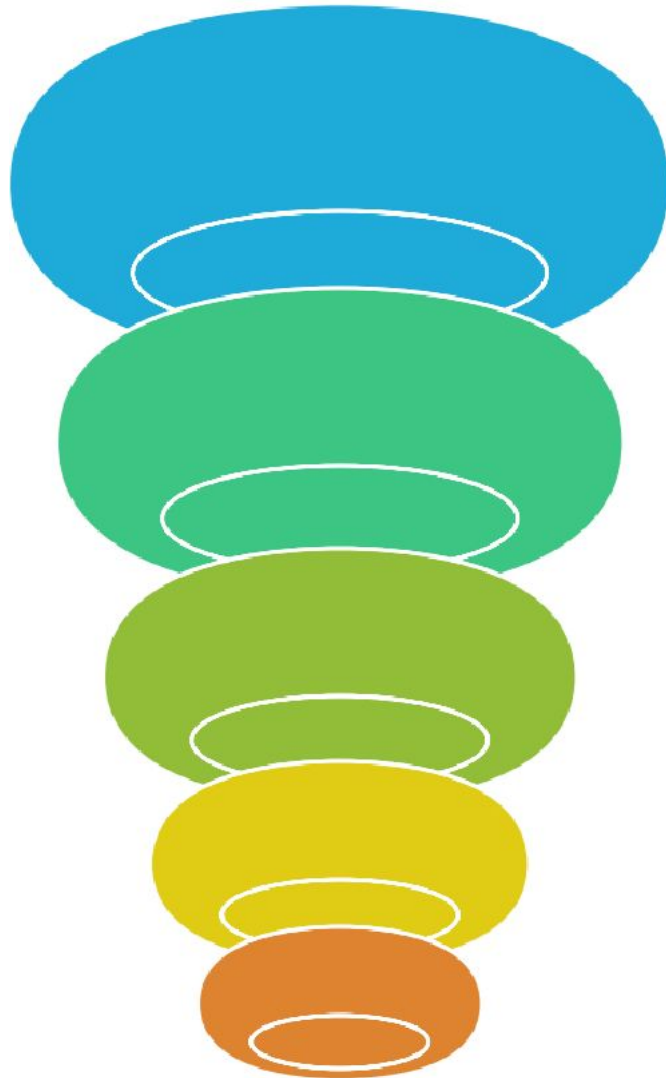


**Computer Vision-based Slab Profiling
System for Optimizing Yield and
Minimizing Defects in Plate Mill
at Bhilai Steel Plant**

Introduction



Objectives



Improve Precision

Enhancing the accuracy of production processes to reduce errors.



Minimize Cutting Losses

Reducing waste generated from cutting operations.



Reduce Waste

Implementing measures to decrease material waste.



Ensure Compliance

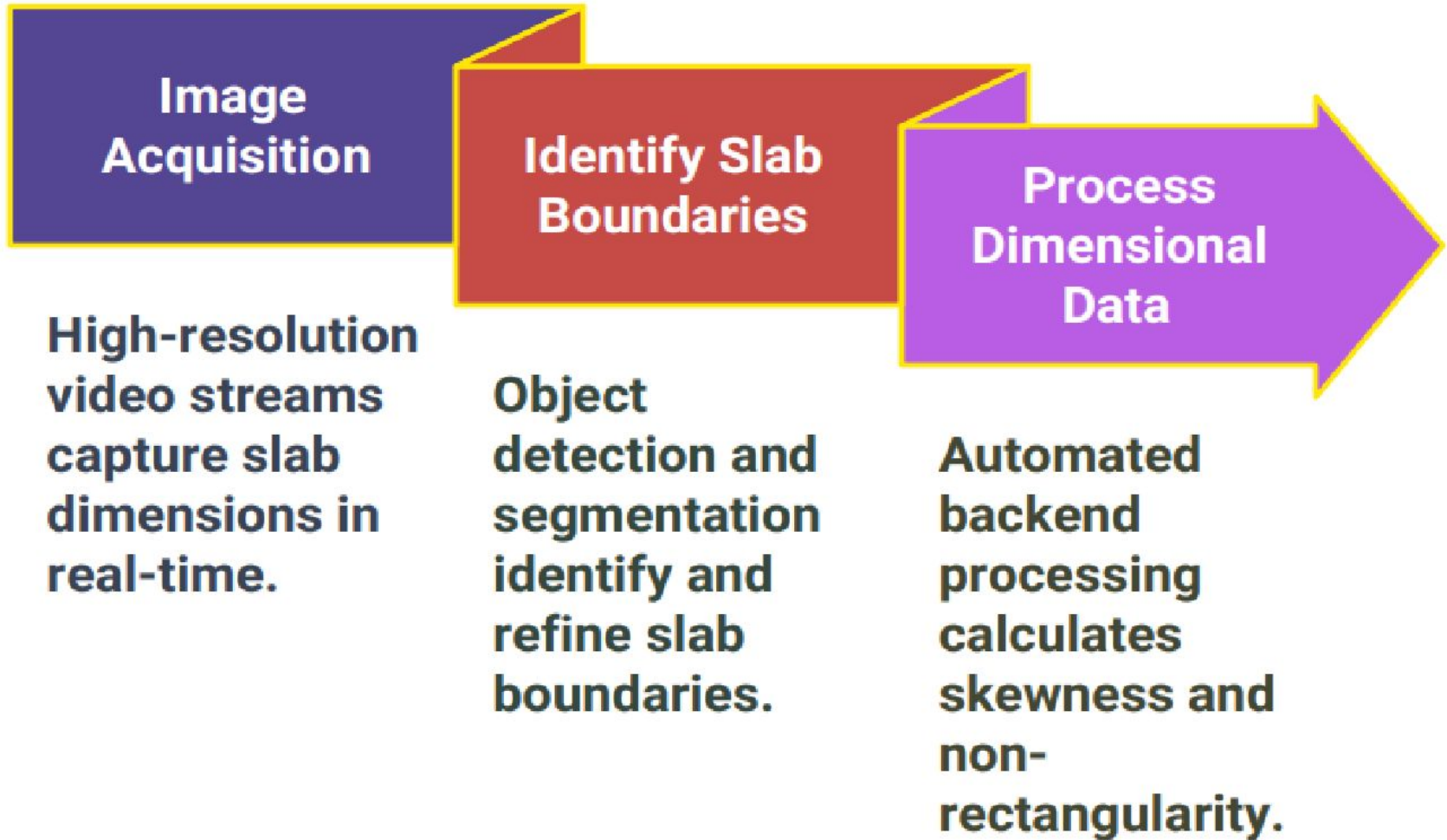
Meeting required tolerance specifications in production.



Integrate with MES

Connecting systems for real-time data and decision-making.

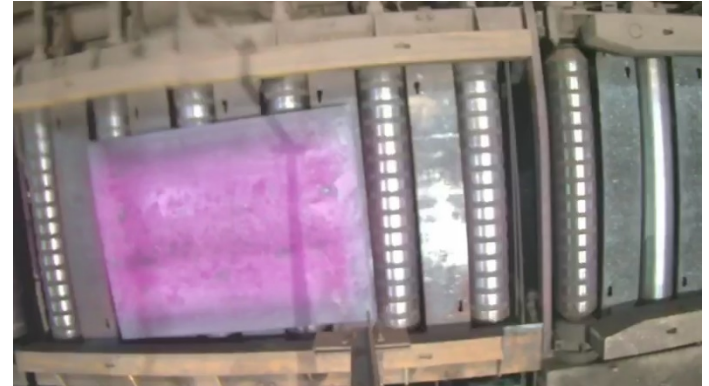
System Architecture



System Architecture

Image Acquisition

- ❑ High resolution video stream to capture live Slab photos
- ❑ Connecting to Oracle Database – for fetching latest Slab details from MES (Slab number, Slab Weight, Slab dimensions)

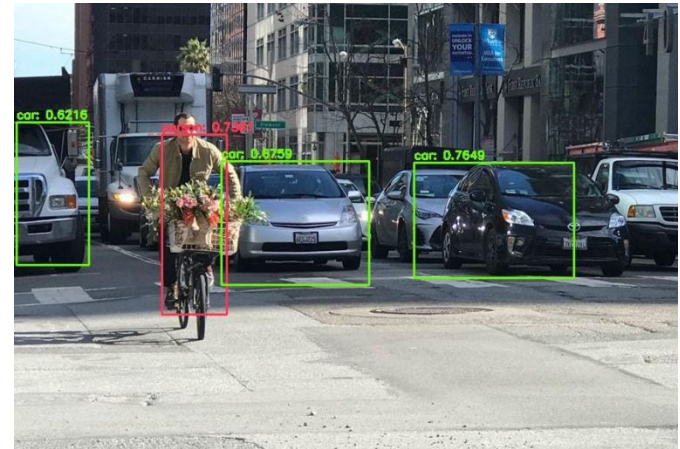


System Architecture

Identify Slab boundaries

- ❑ Uses YOLO and SAM
- ❑ YOLO (You Only Look Once) : detects objects in the image
- ❑ SAM (Segment Anything Model) : Segments the detected objects
- ❑ Extracts Mask & Contours (object outlines) from the segmented area

YOLO



SAM

Process Dimensional Data

- Extracting Slab dimensions
- 4 Points are detected
- Calculates distances between points using Euclidean distance

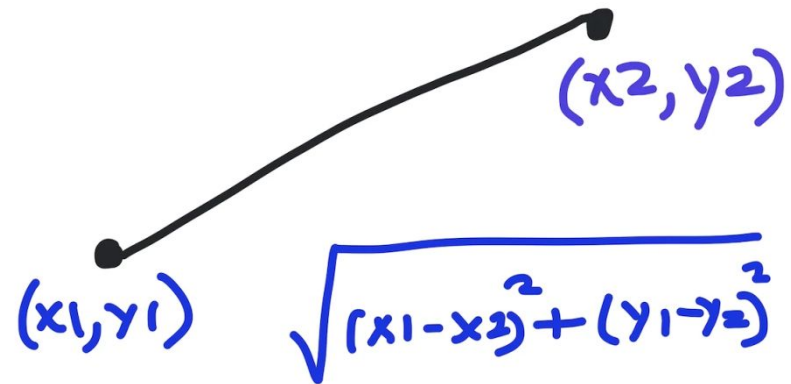
L1 = Length of side CD

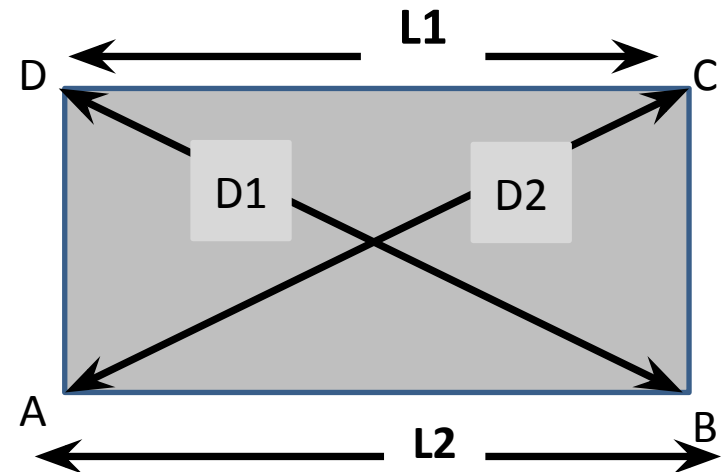
L2 = Length of side AB

D1 = Length of diagonal BD

D2 = Length of diagonal AC

- Returns dimensions as JSON

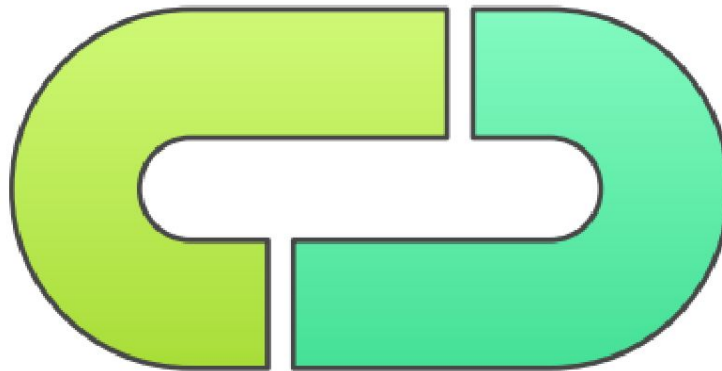

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$



System Architecture

User-Friendly Interface

**Enables real-time
monitoring and
decisions**



Centralized Database

**Stores metadata
like heat numbers
and dimensions**

Benefits

Capacity of Plate Mill : 12,00,000 Ton per annum

If we reduce NCO (Non Conformity of Order) by 0.5 % = 6000 Ton

Difference in Cost of plate and NCO plate = Rs 3000

**Total cost saved (per annum) = Rs (6000 x 3000)
= Rs 1,80,00,000**



Key Features & Benefits

Optimized Yield

Reduction of
end-cutting
losses.



Real-Time Analysis

Enhanced
process
precision.



User Interface

Facilitates
quick decision-
making and
monitoring.



Minimized Defects

Accurate
identification of
taper cuts and
irregular
profiles.

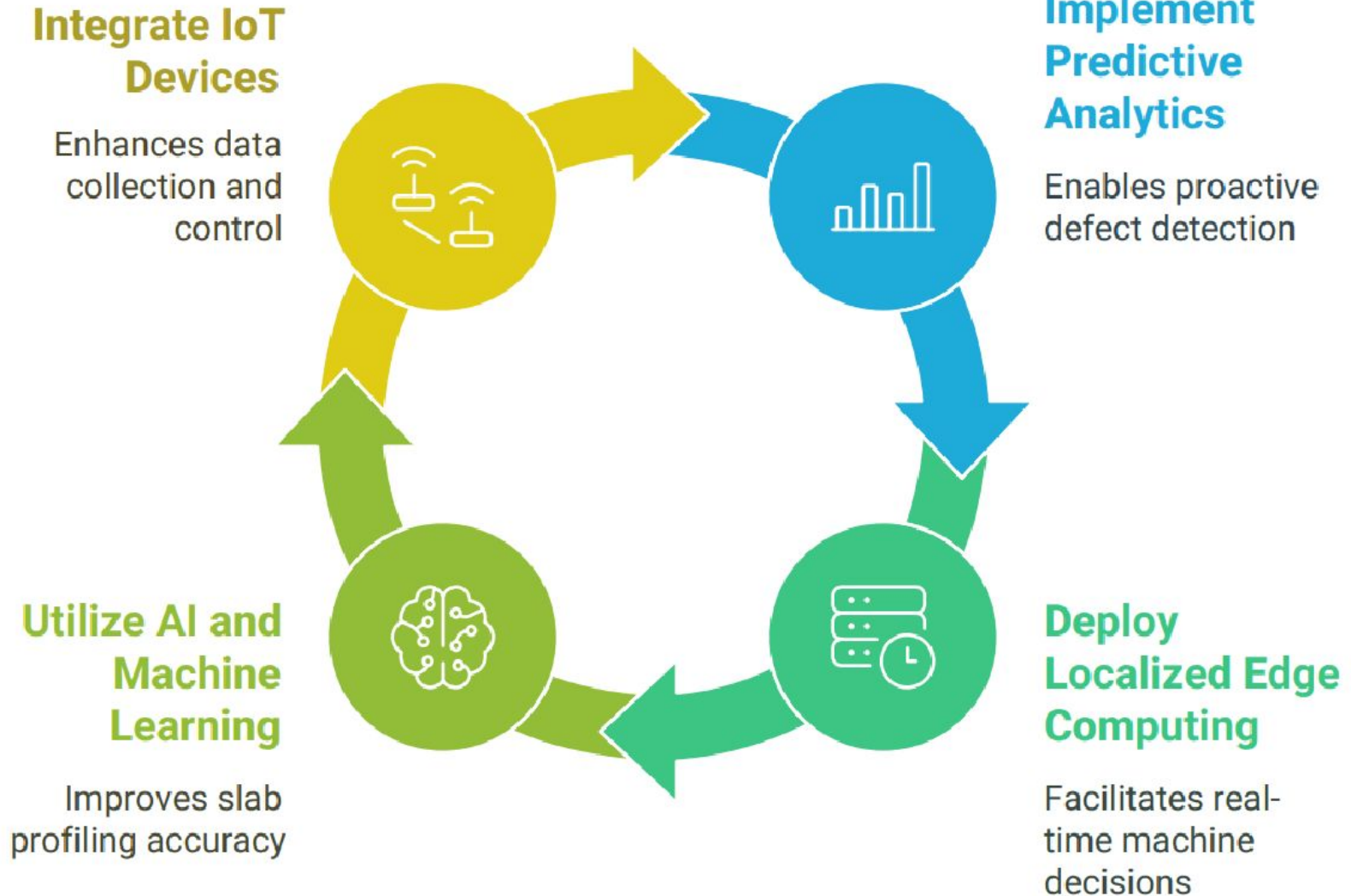


MES Integration

Streamlined
data flow for
better
operational
management.

Future Enhancements

Enhancing Manufacturing Efficiency



THANK YOU!

