



TATA STEEL
WeAlsoMakeTomorrow



tsic@tatasteel.com



capabilitydevelopment.org | 06576 625 253

 www.linkedin.com/showcase/tata-steel-industrial-consulting-tsic

www.tatasteel.com



TATA STEEL
INDUSTRIAL
CONSULTING
YOUR ASPIRATIONS, OUR ENDEAVOUR

**Revolutionary
Solutions In
Steel Technology**

About TATA Steel

Tata Steel was established in India as Asia's first integrated private steel company in 1907. With this, Tata Steel also developed India's first industrial city at Jamshedpur. Today, it is among the leading global steel companies – authoring innovations, pioneering practices, and developing a world class team of committed employees.

In its journey towards excellence, Tata Steel has developed its strengths in diverse areas such as Mining, Steel Manufacturing, Human Resource Management and Industrial Relations, Productivity and Continuous Improvement.



Tata Steel Industrial Consulting - Your Aspirations, Our Expertise

Tata Steel Industrial Consulting (TSIC), the industrial consulting arm of Tata Steel, brings to the table the experience and expertise of the entire Group. The journey of Tata Steel's organisational excellence enables it to offer insights that are applicable across industry groups.

So, what makes Tata Steel Industrial Consulting, services unique and different? TSIC offers more than just consultancy - the vertical comprises practitioners and experienced subject matter experts who have delivered results in an organisational context. This allows them to leverage their practical experience and execute proven solutions!

Revolutionary Solutions in Steel Technology

The Steel Technology Practice of TSIC follows a unique matrix framework within which it adds value to its potential clients. TSIC's services can be classified into two broad categories:

- Technology Based Solutions
- Process Improvement Solutions

Deployment of the company's extensive process expertise and customised technology solutions, garnered over years of experience in projects and operations in the Tata Steel plants, are spread across four verticals-viz.



Ironmaking



Steelmaking



Rolling Mills



Plant Infrastructure

The physical location of the above solutions span the entire spectrum of stations involved in Steelmaking- Coke battery, Sinter/Pellet Line, Blast Furnace, Basic Oxygen Furnace, Continuous Caster, and Rolling Mills.

TSIC's basic building blocks of value-addition entails the following broad areas:

- » Driving down costs by
 - Selecting raw materials considering the entire value chain from raw material to finished product
 - Improving strike rates
 - Reducing energy consumption
 - Designing optimum alloying schemes
- » Delivering high quality products
- » Adding value to by-products

Iron Making

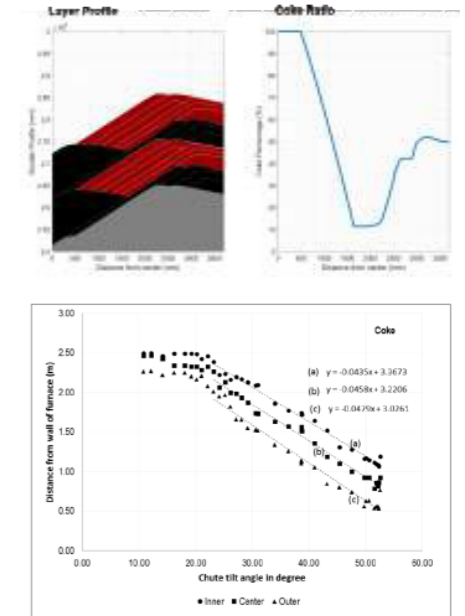
From coarse and rocky iron ore to tough and shiny steel – the making of the alloy is a journey and demands technological expertise of the highest degree. Iron making technologies at Tata Steel have been honed through years of experience for optimal resource efficiency, while enhancing product and process performance. Here are some of the cutting edge technologies that can be leveraged.



Burden Trajectory Measurement

Burden Trajectory System outlines the actual burden trajectory path and builds a burden distribution model. Such a system helps operators to:

- » To estimate maximum permissible angle of the chute at different chute rotation speeds
- » To finalise chute angle for charging sinter coke
- » To determine the material trajectories for coke and metallics charges
- » Develop customised burden distribution model for a new Blast Furnace using trajectory measurement data



Stave Thickness Measurement

Copper staves are utilised in blast furnaces as the best high heat-load wall-cooling element. Stave thickness measurement is required because:

- » To estimate maximum permissible angle of the chute at different chute rotation speeds
- » To finalise chute angle for charging sinter coke
- » To determine the material trajectories for coke and metallics charges
- » Develop customised burden distribution model for a new Blast Furnace using trajectory measurement data

- 2G (Online, Single Point)- Continuous online measurement with permanently embedded sensors
- 3G (Online, Full Channel)- Cutting edge technology enables multi-point measurements along the entire channel of staves. Provides a comprehensive thickness profile along the entire stave

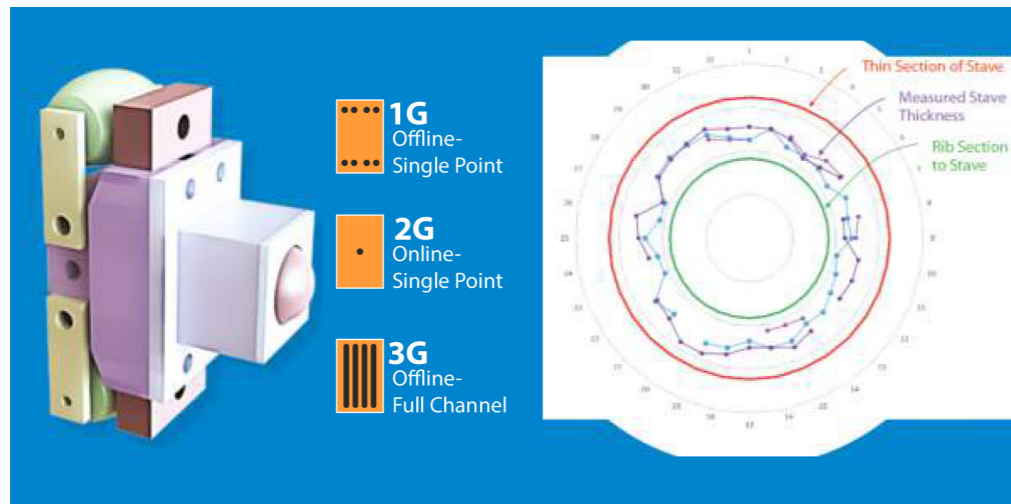
Methodology:

- » It is an ultrasonic sensor-based technology
- » The challenge of accessibility and reliability was overcome by an innovative sensor design
- » There are 3 versions of this technology:
 - 1G (Offline, Single Point) - enables point measurements at inlet/outlet points of staves (up to 8 measurements per stave)

Benefits:

- » The measurements provide a comprehensive assessment of stave condition across the blast furnace
- » Periodic/Continuous assessment of stave health is a valuable tool for optimizing campaign life
- » Aids in safe operation of blast furnaces
- » Helps as a feedback to the operator to control process parameters

In practice at Tata Steel, Jamshedpur for the last 19 years and Tata Steel, Kalinganagar for the last 3 years



Hearth Refractory Thickness Measurement

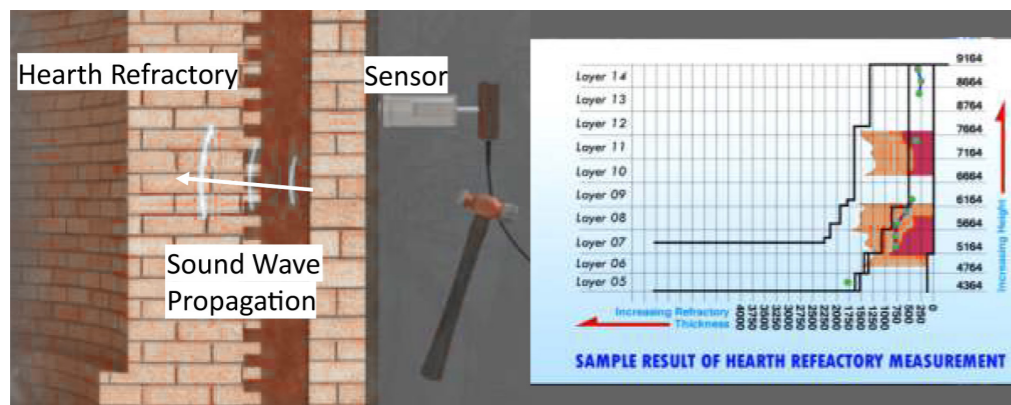
Refractories in the hearth of blast furnaces experience constant wear due to the motion of hot metal. Thickness measurement of hearth refractories is needed to obtain effective extended life of blast furnaces. Tata Steel's in-house development of this Non-Destructive Testing (NDT) technique eliminates dependency on external agencies and reduces cost.

Methodology:

It is a stress wave propagation technique that uses time and frequency data analysis to determine refractory thickness, and detect anomalies such as cracks, gaps, or metal penetration within the refractory lining.

Benefits:

- » This NDT technique measures remnant thickness of the refractory wall and detects flaws
- » Remnant thickness impacts the campaign life of blast furnaces and their safe operation
- » This enables development and implementation of preventive measures to prolong furnace campaign life and continue safe furnace operation
- » These measures include, (but are not limited to) the addition of titania materials, stave washing, grouting, and utilisation of higher quality coke



Steel Making

Tata Steel has undertaken extensive research in making the process of steelmaking more energy-efficient and environmentally sustainable. The company is on a journey of continuous improvement and is pushing the boundaries to evolve its product offerings for a changing world. Here are some of the tried and tested steel making technology solutions that can be customised and adapted for your needs.



SDS: Slag Detection System

The Need

During the processing, a layer of heterogeneous liquid, non-metallic, material called slag is produced. Being lighter, it floats over the liquid steel.

Minimising the outflow of converter slag into the ladle is one of the fundamental preconditions for improved efficiency in the further treatment of steel. Presence of converter slag in the ladle could cause the following problems:

- » Alloy and conditioner additions are hindered by presence of a slag layer
- » A high level of FeO and MnO (slag constituents) result in high Oxygen content of steel, leading to increased processing time and treatment costs
- » Phosphorus and silicon reversion occurs
- » Ladle de-sulphurisation is hampered
- » Poor yield
- » High inclusion formation
- » Increased risk of caster nozzle clogging
- » High wear of ladle refractory
- » Increased consumption of Aluminum
- » Steel quality deterioration

The Concept

A new concept of detecting percentage of slag in the steel ladle at BOF has been introduced at Tata Steel.

SMDS works in the online, real time mode.

- » The image of the metal stream is captured by an infrared digital camera, which is connected to an image processing hardware
- » The thermal image of the tapping stream is displayed on a video monitor for the operator
- » The stream image is continuously analysed to determine the percentage of slag
- » Once the slag percentage in the image is detected, using the permitted slag percentage value, logical algorithms are executed
- » A sub window shows the extent of slag in digits and on a bar graph. Several user accessible data are also displayed via interactive screens
- » An alarm is generated at a pre- set value of slag percentage in the stream for the vessel operator



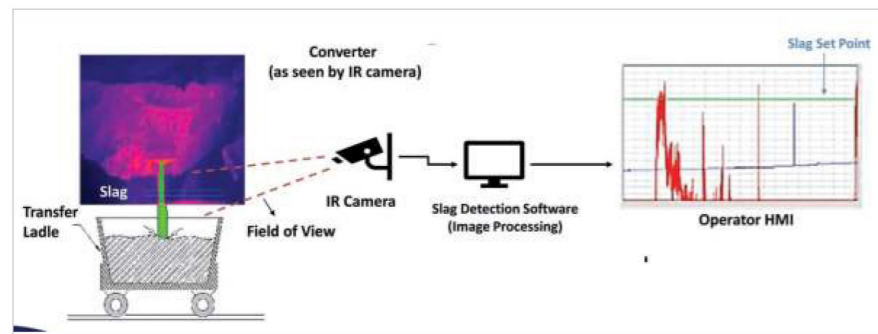
Benefits:

- » Automatic detection of slag percentage
- » Eliminates manual intervention by application of computer vision architecture to decision-making
- » Increases yield, quality, and productivity
- » Operator ease



Key Performance Indicator:

Minimise yield loss in the tapping process



Rolling Mills

Tata Steel has forever been at the forefront of cutting- edge Rolling Mills technology- where the product acquires its final marketable shape. Over the years, technology additions and enhancements to the Rolling Facilities have ensured world-class quality, safety and optimisation for a sustainable tomorrow.



In practice for the last 13 years at Tata Steel, Jamshedpur, and the last 3 years at Tata Steel, Kalinganagar

OPTITHERM: Reheat Furnace Level II System

The Need

- » In hot rolling of steel, the uniform heating of flat or long semis at exactly the right temperature and their timely delivery to the rolling mill is extremely critical to product quality, mill performance, and cost of manufacturing
- » The semis need to be delivered to the mill at the required temperature, with minimum fuel consumption, and uniform temperature all across
- » The zonal temperatures inside the reheating furnace are controlled through set points which need to be determined dynamically to achieve quality heating in various production scenarios. Manually controlling these set points compromises the quality of heating of the semis and therefore the quality of the end product

The System

- » Level 2 automation for reheating furnaces is an online furnace temperature control system whose main task is to provide optimally heated steel semis to the rolling mill for various production requirements

- » It controls the furnace temperature to achieve the required discharge temperature of semis, low oxidation losses, and less energy consumption while ensuring reheating quality
- » The system also provides furnace visualisation, furnace health check, and web reporting



Benefits:

- » Portable, scalable, and easy to maintain solution
- » Seamless integration with business planning systems and mill automation
- » Provides material tracking in the furnace area
- » Online temperature calculation and zonal temperature control
- » Models for hot and cold semis mixed charging
- » Thermal history of slabs as they are heated through the furnace
- » User friendly HMIs and web- based reports
- » Tools for in-depth analysis of the reheating process



Key Performance Indicator:

- » ≈10% reduction in fuel consumption
- » ≈11% reduction in scale formation



In practice for the last 15 years at Tata Steel, Jamshedpur, and the last 3 years at Tata Steel, Kalinganagar

TSIC's 5-step approach

TSIC's 5-step approach prepares clients for the next performance frontier.

Prepare	Diagnose	Solution design	Implement	Sustain
Understand Context (Plant, Systems, Processes)	Understand Context (Plant, Systems, Processes)	Identify tools, technologies, frameworks etc. based on levers	Gantt Charts, CCPM	Institutionalising through DM frameworks and audits at regular intervals
Gather Data	Identify normal and abnormal cases	Identify tools, technologies, frameworks etc. based on levers	Identify SMEs/ support from TSL	Enable system, identify new constraints
Validate/Clean Data	Determine variances	Squad Formation		
Interact with shop floor (understand pain area)	Determine variances	Establish causeeffect		
	Identify Levers for improvement			



Aspiring for a better tomorrow

Tata Steel Industrial Consulting's Steel Technology practice covers the entire gamut of the steelmaking process viz. Ironmaking, Steelmaking, Rolling Mills, and Plant Infrastructure. It straddles both, Technology Based Solutions as well as Process Improvement Solutions. Given the vastly experienced consultants, who have hands-on successes in executing projects involving modern tech tools and management practices, any fresh challenge in their path can be easily met with exceptional results.

Hence, any company aspiring to upgrade to tomorrow's technology today, and imbibe the latest in management and process improvement techniques, does not have to look beyond TSIC for the ideal navigator cum project executor!

“

**It always seems
impossible until
it's done**

”

- Nelson Mandela





Automation Solutions

The Automation Division of Tata Steel was established in 1992 to develop process optimization solutions through applied research and provide associated operational support to the production units of Tata Steel through Product Life cycle management. We are a multi-disciplinary group of engineers & researchers with expertise in implementing total automation solutions involving Research & Development, Instrumentation, System Integration, Intelligent Systems & Mathematical Modelling Software Engineering & Development. Our services include

Raw Material:

Auto-dispatch: Autodespatch is a web based real time production and monitoring system for open cast mines that enables the centralized monitoring, control and optimization of all mining activities. It tracks all the vehicles, enables optimum scheduling of operations and maximizes utilization of major assets.



Features

- » Centralized on-line tracking of HEMMs on a GIS map
- » Configurable GUI(Graphical User Interface) and iconic representations of monitored HEMMs
- » Individual and cumulative tracking of HEMMs with the changes in states (loaded, empty, wait etc.) also visually represented
- » Replay of vehicle movements
- » KPIs (Key Performance Indicators) of online monitored HEMMs, are stored and displayed in a customizable format for advanced reporting, trending and analysis



Benefits:

- » Increased employee involvement
- » Provides real-time accurate information
- » Provides actual productivity and utilization information for optimizing the processes
- » Monitor engine conditions and fault diagnosis for better maintenance and reliability



Coke and Iron Making

Tuyereye:

With the advent of Pulverized Coal Injection (PCI), constant monitoring of the tuyeres & the raceway has become important in order to avoid tuyere blockages. Tata Steel has developed the Tuyereye, a vision-based furnace monitoring system which can be used to observe the condition of the tuyeres online using advanced image processing techniques.



Features

- » Online inspection of all tuyeres of blast furnaces through CCD cameras using image processing techniques
- » Shows the thermal profile of the tuyeres indicating the temperatures, heat-zones and the blockage of the tuyeres as a percentage
- » Above a threshold value of the blockage, it generates an alarm for the operator to take necessary action
- » The live image and thermal profiles are retrieved in the form of movies and displayed for the selected tuyeres for live as well as historical data
- » The camera arrangement allows for both manual and automatic inspection

COSMOS:

COSMOS ensures stable coke temperature by implementing mathematical model-based heat input control and a disciplined charging and pushing schedules. Machine coordinator keeps track of machine operations such as charging, pushing, coal intake and its movement and interface with the scheduling system.

Features

- » Mathematical model-based heating control
- » Charging and pushing scheduling
- » RF communication based inter-machine communication
- » Inter-machine interlocks to ensure correct and safe operation
- » Automatic oven machines positioning
- » Oven maintenance module for generating maintenance schedule
- » Oven condition monitoring
- » User friendly interfaces

Provide BF:

Blast Furnace Level2 system is a collection of mathematical & mass-energy balance models which, based on first principles, mathematical equations and numerical methods, simulate the blast furnace process in segments (charging, blowing, tapping) on real time basis. The models extract plant data like flow, temperature, pressure, distance, velocity etc from the field devices and convert them into trends using fundamental principles of physical laws.

Features

- » Blast Furnace Level2 System is built on following basic features:
- » S/W Architecture
- » Process Models
- » Interfaces

Furnace Scope:

Furnace Scope has been designed for continuous visual observation of whole blast furnace top interior and not for thermal pattern monitoring. Furnace Scope monitors the gas flow at the furnace top, and observes the surface of ore or coke when their temperature exceeds the proper level. Furnace Scope provides the operator with an image of the above threshold temperature gas flow through the ore and coke dust.

- » Furnace Scope provides the operator with an image of the material surface when temperature of the charge is at above threshold level
- » Furnace Scope also provides an image of low temperature objects as it is equipped with a CCD semiconductor with higher sensitivity at low temperature



Steel Making and Casting

OptiBOF:

Automation Division, TATA STEEL has implemented OptiBOF - a comprehensive higher Level-II automation in both its steelmaking units i.e.,- LD #1 and LD #2 shops. OptiBOF brings in standardization of operations, consistency in end blow chemistry and temperature and provides assistance in the planning of heats in the shop by integrating with Planning systems and other production units in the shop. Further the optimization models contribute significantly to the savings in raw materials and improvements in vessel life.

Benefits:

- » Reduced reblows
- » Optimized charge balance
- » Standard operational practices
- » Effective process analysis

Slag Monitoring and Detection System:

Slag Monitoring and Detection System works in real mode and analyses the molten stream of metal to detect the slag percentage in it. Implementation of SMS system increases the productivity, performance and purity of steel. It is designed to give ease to the operator and improve the quality of product. SMDS is developed for simulation and real time working mode. Customization as per the local environment and local situation is required and will be done at the local commissioning site only.

Benefits:

- » Automatic detection of slag %
- » Eliminates manual intervention by application of computer vision architecture to decision-making
- » Increases yield, quality and productivity

Casting Online Diagnostic System:

Casting is a critical step in steel making. Conversion of molten steel into slabs while casting may lead to spill out of molten steel around the mould bottom. This phenomenon is known as breakout. Breakouts can cause the damage of the caster, loss of production and poor safety records. To prevent breakouts, Automation Division, Tata Steel has developed a Casting Online Diagnostics System (CODS). Breakouts can be detected while the molten steel is inside the mould. It has been observed that 90% of the breakouts happen due to sticker and such breakouts are known as sticker breakouts.

Features

- » Prediction of all types of breakouts-stickers, cracks, thin shells, start-ups, slag entrapment, etc.
- » Handling all steel grades and casting speeds up to 2.2 meters/min
- » Predicting a value of 'breakout ability'- inverse of 'normality'- in real time on a continuous scale of 0-100, rather than a binary response in terms of breakout/no-breakout; thus providing a view of the health of casting rather than just indicating the failure whenever it occurs
- » Fuzzy systems convert thermal and casting conditions into breakout ability along with identification of the cause of highest breakout-ability, the location in the mould, of the point of highest breakout ability (or farthest from 'local normal') and the nature of evolution of this fault point

Trusquare - Billet Rhomboidity Measurement System:

An automatic, online, cost effective system for measurement of percentage rhomboidity of billet face emerging out of various strands of caster with the capability to operate under harsh environmental conditions was developed inhouse by Automation Division of Tata Steel.

System Features

- » Accurate, real time rhomboidity measurement of each billet
- » Measurement method-one face of every billet
- » Strand wise data
- » Accuracy: +- 2 millimeters (1.5%)
- » Robust water-cooled camera enclosure for protection from dust, humidity & heat
- » Higher safety since the measurement is non-contact type.
- » Robust algorithm precisely computes the rhomboidity even in presence of 55% occlusion of the object face by the scales.

Therma - Eye:

The prime objective of the Raking operation is to skim out the slag formed at the end of the injection process to rid of the Sulfur from the hot metal coming out of Blast Furnaces. Raking is done manually, and operator takes the decision when to stop RAKING, thus judgment on the quantity of the remaining slag on the ladle surface rest with the operator. There could be chances of under as well as over raking. Both are detrimental. If it is under raked, more slag will go to the converter and thus chances of Sulfur reversal would be high. Similarly, in the case of over raking, high hot metal yield loss occurs. To prevent this scenario and to achieve standardized raking operation, an Image processing based Automatic Surface Slag detection system using Infrared Thermal Camera need to be developed. This system would continuously monitor the slag content on the ladle surface and initiate alarm if the slag content reaches a predefined threshold level set by the engineer or supervisor.



Rolling Mills

Optitherm – Process Control Solution for Reheating Furnaces

Tata Steel Automation Division offers you a Level 2 automation system for delivering optimally soaked flat or long semis through furnace temperature control which has a significant impact on the product quality. The system has been developed using in-depth understanding of hot rolling technology and years of experience in developing automation solutions.

Level 2 automation for reheating furnaces is an online furnace temperature control system whose main task is to provide optimally heated steel semis to the rolling mill for various production requirements. It controls the furnace temperature to achieve the required discharge temperature of semis, low oxidation losses, less energy consumption while ensuring the heating quality. The system also provides furnace visualization, furnace health check and web reporting system.

V.Eye- Crop optimisation system with accurate mill speed measurement system:

We have developed a vision based system for crop cut determination coupled with an accurate strip speed feedback to the crop shear, to significantly reduce the crop cut length & loss of steel.

Features

- » The major system components are:
- » Machine vision system for imaging of head & tail ends and strip speed measurement, up to 3rd order time derivative of distance
- » Efficient and robust algorithms to determine speed & image profiling even in presence of flowing scales and black patches
- » Pin-hole enclosure design to protect opto-electronics from extremely harsh plant conditions
- » High resolution CCD cameras with robust enclosure for maintenance free performance
- » Provision of manual settings for cut position

TRUSPAN - Online Width Measurement System for Rolling Mills:

TrueSpan has been developed for online width measurement of strip in Hot and Cold Rolling Mills. TrueSpan can be configured for stereoscopic measurement of strip with varying HOP and TILT on the roller table. TrueSpan is developed to provide a very high-speed width output maintaining high precision measurement accuracy under all mill conditions.

Features

- » High-resolution line-scan CCD cameras with environmental enclosure (for long & maintenance free life)
- » High-speed image processing on digital signal processors for real-time width measurement
- » Image processing computer
- » Flat screen color graphic display
- » Measurement accuracy

Surface Defect Logging System:

Defect logging system facilitates the logging of top and bottom surface defects found on a coil in an innovative, user-friendly, virtual coil map. Non-standard, new defects and/or any defect properties that need to be mentioned can easily be done using a free-hand drawing facility built into the system.

- » Important features of the system also include: Separate line online defect logging facility and automatic ACCEPT or HOLD decision w.r.t surface and shape standard of a coil.
- » Inspection of both top and bottom surface simultaneously and combined decision by the system.
- » Online feedback to previous process lines as inspection data is stored in a central server. An "Expert system result" facilitates the process of up-gradation or down-gradation w.r.t the quality of surface and shape.
- » Evaluation of severity of shape defects with inspector measured values of shape parameters. User-friendly reports aiding in decision making.

SQUINS - Surface Quality Inspection System:

Tata Steel Automation Division offers you a vision product to tackle your challenging tasks of detecting surface defects automatically and to develop the kind of vision system that you need for your application. SQUINS is an online system for detection of surface defects and tracking product performance at every stage.

Objectives

- » Reliable detection - "Zero" defects missed
- » Discretion – Alarms are raised only for significant defects
- » Accurate Classification
- » Revised gradation standards

Dehole - Hole detection System

High Speed Hole Detection System to Verify Sheet Integrity as It Is Being Rolled

Features

- » Capable of detecting holes as small as 0.5 mm² at speeds as high as 240 mpm
- » Audio-visual alarm and line stop on hole detection
- » High speed, high resolution system for 100%-hole detection
- » Low power, highly reliable LED strip backlighting for 24x7 operation
- » Efficient blob detection and contour tracing algorithm for faithful hole detection
- » Hole location and size information immediately presented to the operator & embedded in the log history of the coil

Utilities

Yard Management System:

Generic Yard Management System (GYMS) is an integrated product that takes care of various kinds of material handling. The system provides various options to customize different resources in the yard and plug-in options to integrate new functions. It has generic templates for interfacing with other systems. GYMS provides comprehensive automation solution in asset visibility control and optimization in material handling by extending real-time control and management to yard operations. The system is developed using latest and robust technology to make it a scalable, reliable and platform independent product in material handling.

Benefits:

- » Easy to use human machine interface for real time visibility of all yard activities
- » Hand held terminal for the operator to perform field verification and server communication
- » Interfaces with business planning systems, process lines and crane automation systems
- » Centralized database to manage all activities from receipt to dispatch of materials
- » User friendly & configurable
- » Data archive for future analysis

Torpedo Ladle Tracking System:

The Torpedo Ladles Cars (TLCs) in steel plants serve as capacity buffers of hot metal to the blast furnaces and as feed buffers of hot metal to the steel making shops. Efficient co-ordination of torpedo ladles is of paramount importance to any steel plant for minimizing hot metal dumping and ensuring optimum supply of hot metal to the steel making shops.

Features

- » Online data of hot metal production
- » Online tracking of TLCs' position & weight.
- » System predicts the TLC re-lining schedule based on tare weight and TLC condition.
- » Online consumption of hot metal at steel making shops.
- » Breakdown & maintenance reports of TLCs.
- » Online chemistry of hot metal to enable steel melting shops to achieve desired steel grades.

Laboratory Management System:

Laboratory Management System is a software focused on informative, efficient & cost-effective management of steel chemistry data in a steel plant with the objective of providing online data to steel making process for model calculation, verification & accelerated decision making. It enhances the data visibility across the steel plant in real time & archives the data for future analysis. It also helps to monitor the performance of the laboratories.

Features

- » Web based software
- » Real time data for hot metal, steel & slag analysis etc.
- » Monitoring of laboratory performance through time taken for analysis & report preparation
- » Integrated analytical tools like control charts etc.
- » Facility for verification of steel chemistry against specifications
- » Facility for suggesting possible grades in case of chemistry deviation
- » Excel downloadable reports
- » Customizable as per user requirement
- » Multi-user system
- » Search facilities
- » Reports available in desired formats

