Integrating Technology, Operations and Economics to enable production of high quality steel

Indian Steel Quality Standards

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M.N. Dastur & Co. (P) Ltd.

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DASTUR

M. N. Dastur and Company – Our Story…

1955 - 2018

60+

Inseparable from India's Industrial growth for over 60 years

Tebodin B.V.

AEC Engineering

Hatch

McKinsey & Company

Engineering and Consulting leader

Metals | Mining | Energy | Infrastructure

Business | Finance | Engineering | Operations

Recent partnerships and endorsements

"Dastur is a world class organization … excellent work product. We are thrilled with the progress and partnership."
- David Cheney, Chief Executive Officer, Stelco Inc

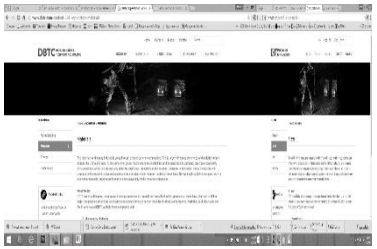
"Consulting assignments worth tens of millions of dollars without creating a lasting impact will be replaced by the application of deep technical and economic I.Q., combined with an intuitive understanding of the markets that can create measurable results
- Peter Marcus, the Founder and Chairman Emeritus

"One of Tata Steel's most valuable partners for decades, Dastur has been involved intimately in the planning, engineering and commissioning of many major projects hand in hand with Tata Steel, making major contributions along the way …."
- Anand Sen, President TQM & SB

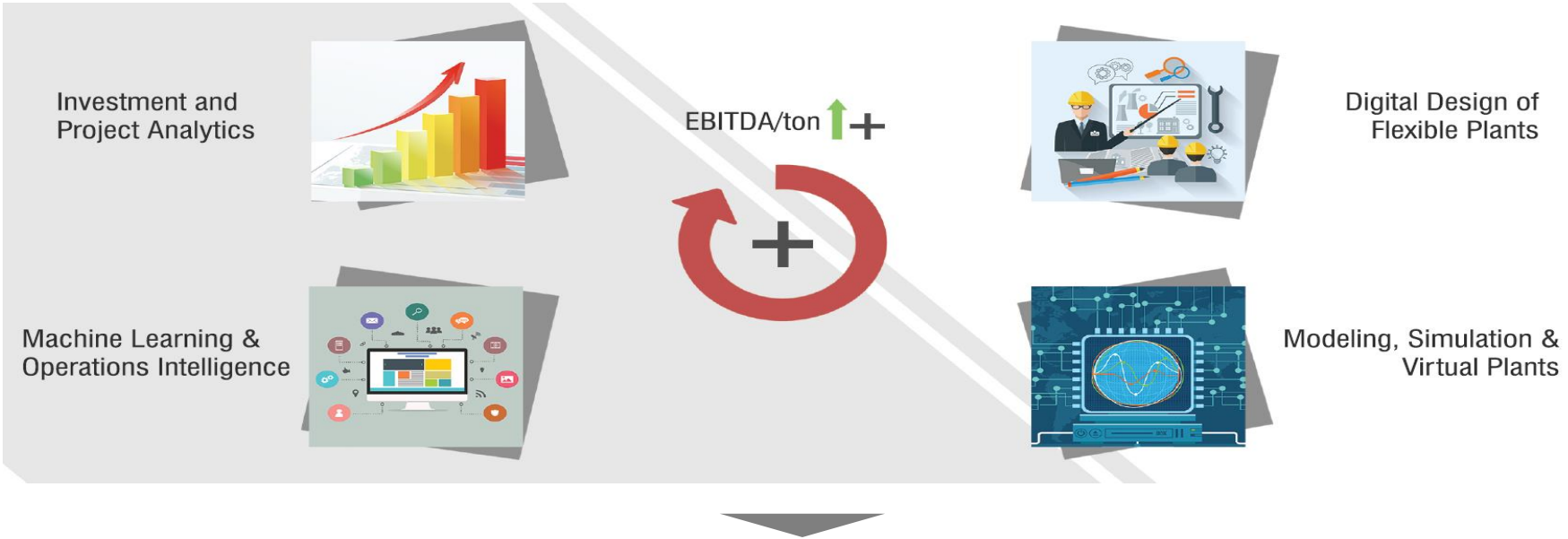
"Dastur has been instrumental in helping JSPL in its journey to be one of the most valuable and best-in-class steel producers. We are excited to have Dastur as our partner"
- Naveen Jindal, Chairman

We believe that Dastur's storied history and world-class expertise in the metals, mining and energy industries will complement the NCCC's world-class research and technology capabilities in carbon capture.
- Frank Morton, Director (USA)

DASTUR operations offerings

Raw Materials	Operations Improvement			Product Mix
				
Sourcing Optimization	Cycle Time Reduction	Utilization Studies	Capacity Strategy	Product Mix Rationalization
Feedstock Substitution	Bottleneck Analysis	Hidden Capacity Extraction	Supply Chains	Direct Cost Reduction
Supply Chain Re-design	Logistics Re-sequencing	Capacity Consolidation	Operations Optimization	Channel Improvement
Direct Cost Reduction	Quality Control	Capacity Re-sequencing	Production Planning	Pricing Redesign
Contract Re-engineering	Operations Bench-Marking	Vertical Integration	Plant Maintenance	Post Merger Consolidation
Financial Engineering	Productivity Improvement	Scale & Flexibility Options	Modeling and Simulation	Marketing Spend Optimization

Driving synergy between Technology, Engineering, Innovation, Operations & Economics



Approach to Process Improvement & Engineering

Process Modeling & Simulation

- Process Design and re-engineering
- Computational Fluid Dynamics
- Thermochemical reaction modeling
- Logistics and Plant simulations

Deep Learning & AI

- Industrial Analytics
- Machine Learning for industrial processes
- Through process visibility
- Big Data

Engineering & Technology

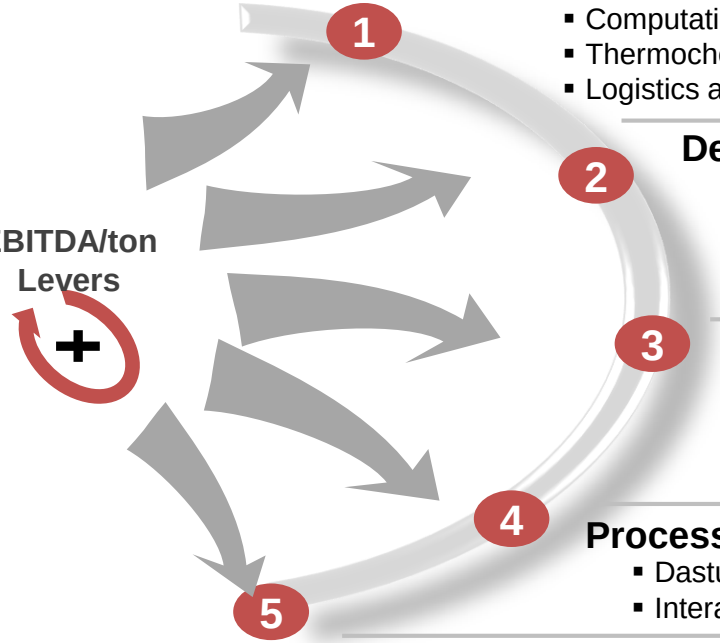
- Basic, Detail
- Project management
- Implementation/Support

Process Knowledge

- Dastur knowledge bank
- Interactive knowledge transfer

Test Work and Experimentation

- Water modeling / liquid metal modeling
- Pilot scale tests



Economics of Process

- Market & product mix
- EBITDA/cost analysis
- Investment analysis
- Asset restructuring
- Operations re-engineering

Case studies

I. Production of high quality flat steel using ‘BF + EAF’ operations

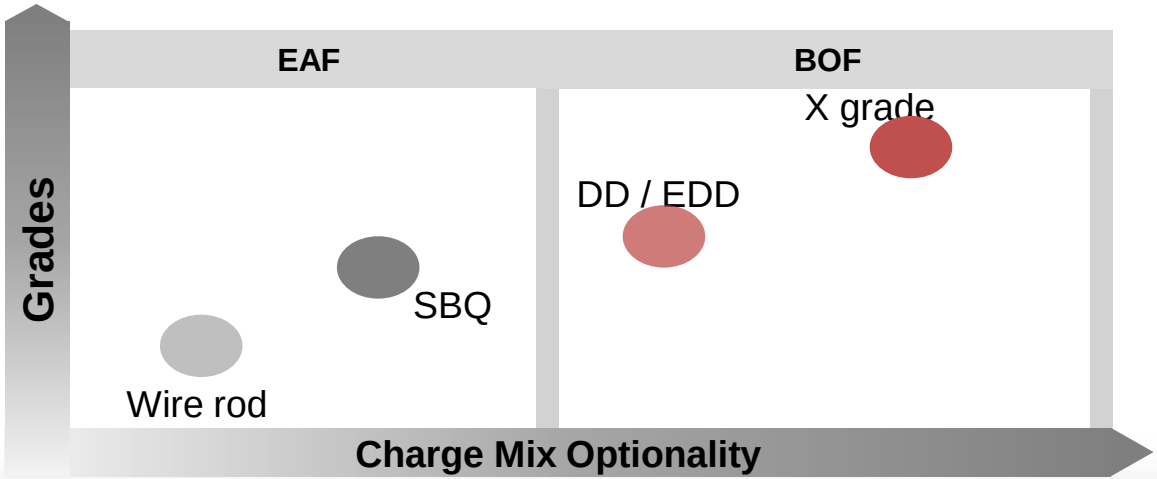
II. Reducing end blow phosphorous at a premier steelmaker

III. Predictive model development for desulphurization of steel

IV. Logistics Simulation / Re-sequencing

V. Coal Gasification

Case Study I – **Production of High quality flats using EAF + Mini BF operations**



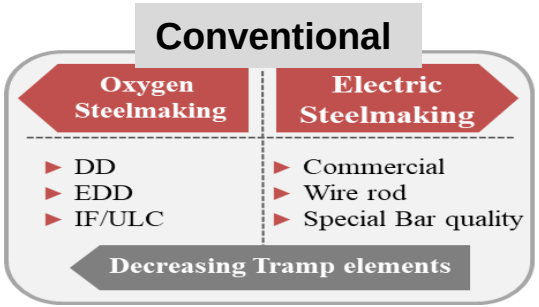
Production of New grades

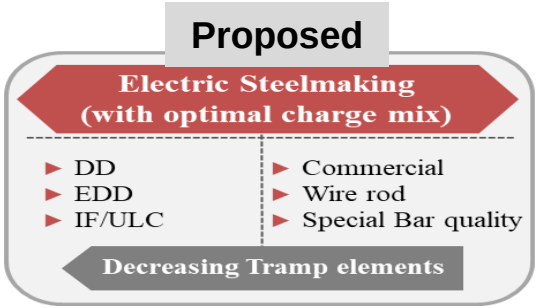
Optimal charge mix for a given grade

Lifecycle Cost-competitiveness

Possibility of HM charge

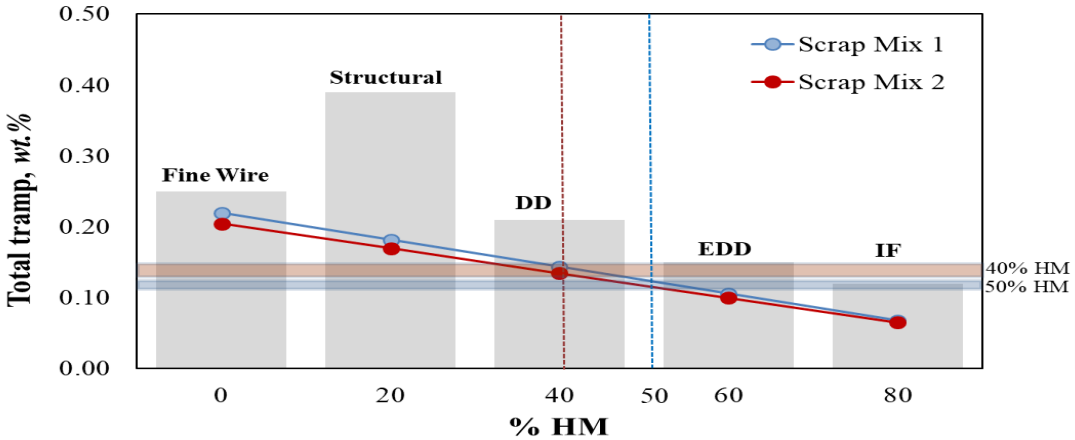
Case Study I – **Production of High quality flats using EAF + Mini BF operations**





DD: Deep Drawing, EDD: Extra Deep Drawing, IF: Interstitial Free, ULC: Ultra Low Carbon

Charge Mix vs grades produced



- Almost all the grades can be produced with 40% HM in charge
- IF grade necessitates around 50% HM + scrap or 40% HM + DRI and scrap

•Scrap Mix 1: 85% Reclaimed/Obsolete + 12% Revert/Home + 3% Industrial/Process
•Scrap Mix 2: 75% Reclaimed/Obsolete + 20% Revert/Home + 5% Industrial/Process

Case Study II – **Determination of Optimal BOF Parameters to Reduce End Blow Phosphorus**

9% downgrade reduction, 5$/ton EBITDA Impact

Process Data

BOF

In blow addition Data

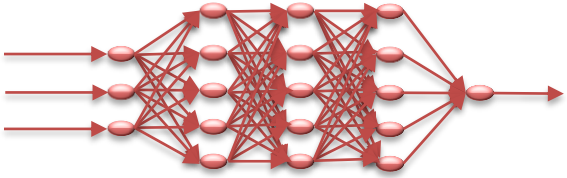
Slag composition Data

Input HM Chemistry

Charge Data

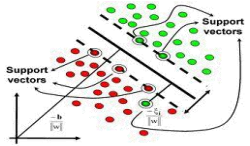
Steel Chemistry

Deep Learning Engine



- Signal Processing and Data Filtering
- Deep Learning Algorithms
- Advanced Clustering Techniques to segment heat profiles
- Sequencing and Selection of Optimum profile

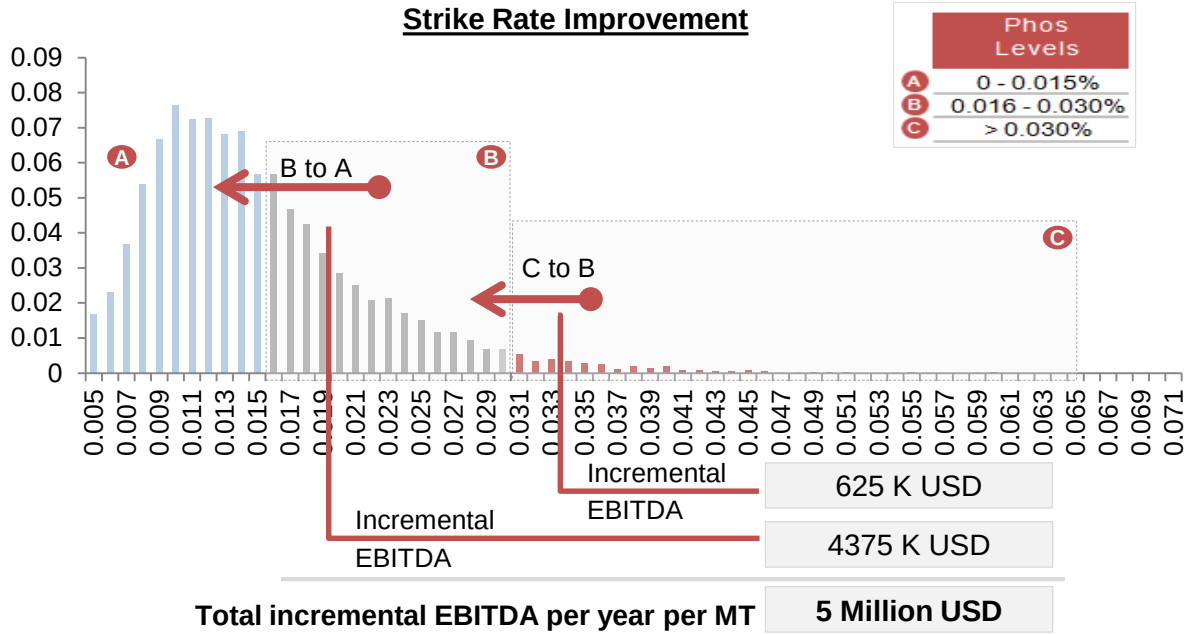
Optimal BOF Parameters

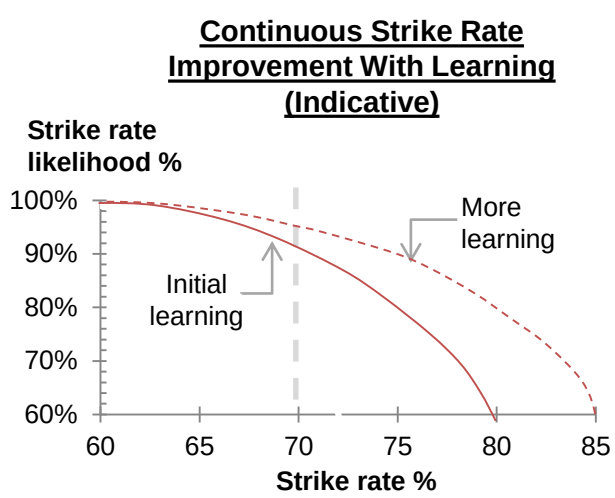


For each grade of Steel, optimum operating conditions of

- Lance height profile
- Addition profile for
  - A) Lime
  - B) Dolomite
  - C) Iron Ore
- Stirring Energy band

Case Study II – **Incremental EBITDA Generated by Increasing Phos Strike Rate**



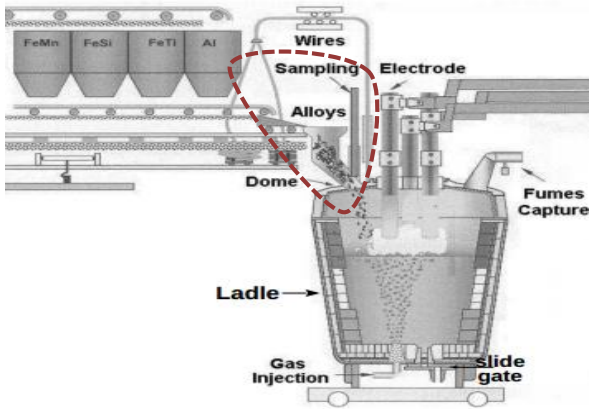


Methodology

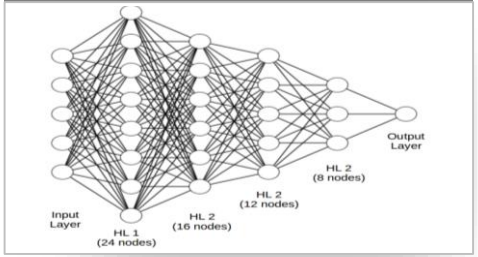
1. Phos levels are categorized into three groups – A(low), B (medium), and C (high)
2. Moving steel from B to A generates incremental EBITDA $ 69/t, and from C to B generates incremental EBITDA $ 30/t

Case Study III – **Development of a predictive ladle de-S model**

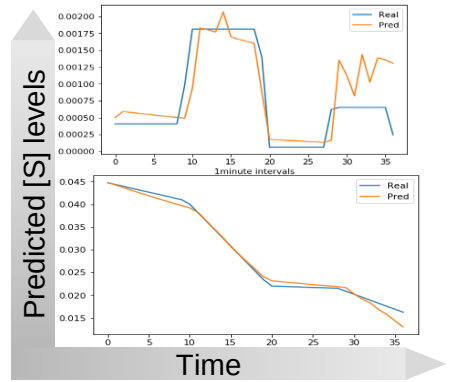
LRF and its auxiliaries



AI/ML Model



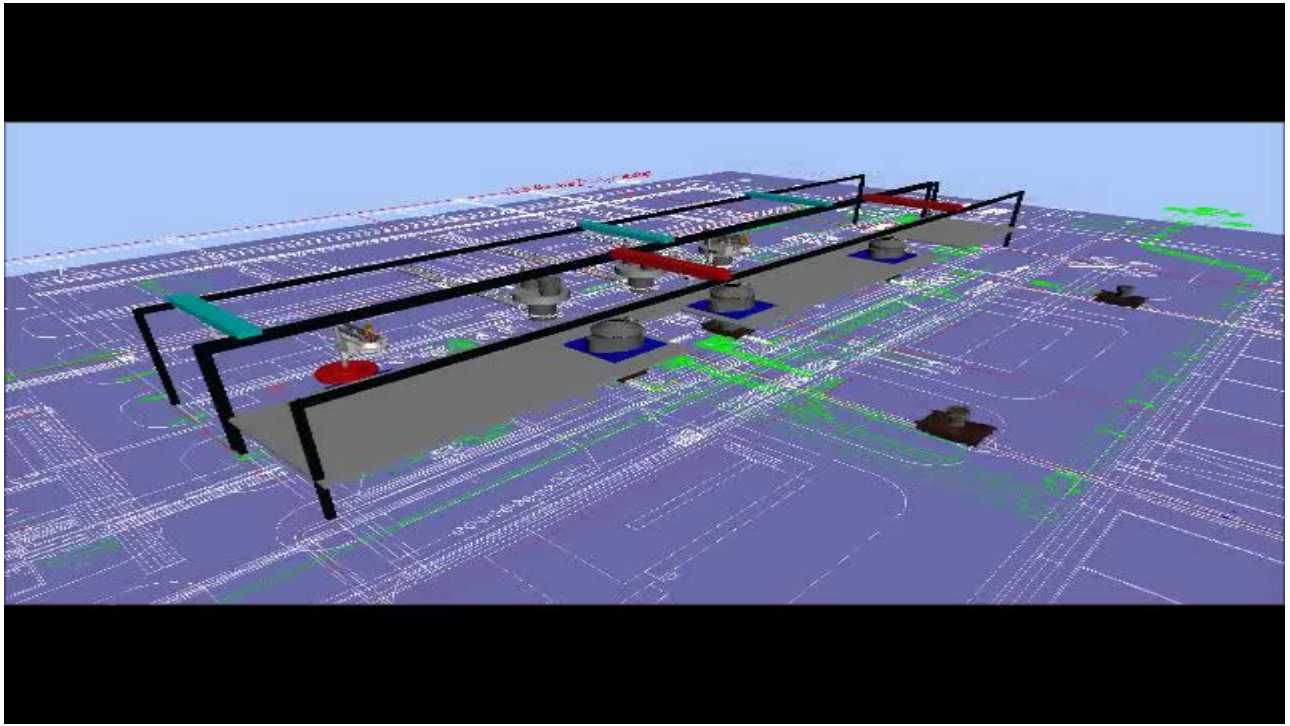
Predictions from the model



Operator + Dynamic Monitoring and Feedback

- Online: avoid delays (elimination of sampling)
- Precise: attain close end-point control
- Result in a lower cost of operation

Case Study IV – **Logistics Simulation for SMS for Throughput Optimization**



Tasks accomplished

- Identification of the **bottlenecks** causing capacity loss
- **Sensitivity analysis** to redesign the system
- Suggest mechanisms for **improvement**, additional facilities and logistical resources

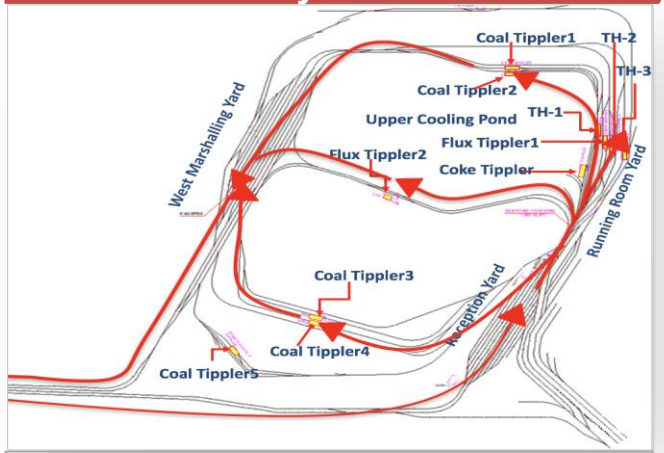
Impact of Simulation

- **Optimum number of ladles** in active circulation
- **28% increase** in melt-shop **throughput** &
- significant increase in profitability by decreasing liquid steel diversions

EBITDA/ton improvement = ~ **4-6 $**

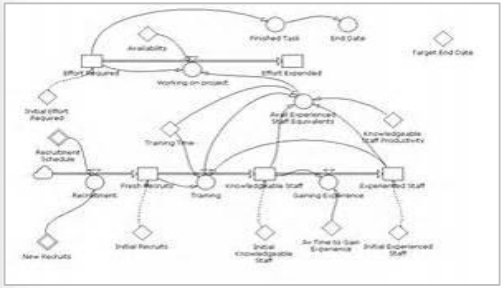
Case Study IV (i) – **Logistic Rerouting, Resequencing and Asset Optimization**

Sub-optimal Raw Matl. Handling System



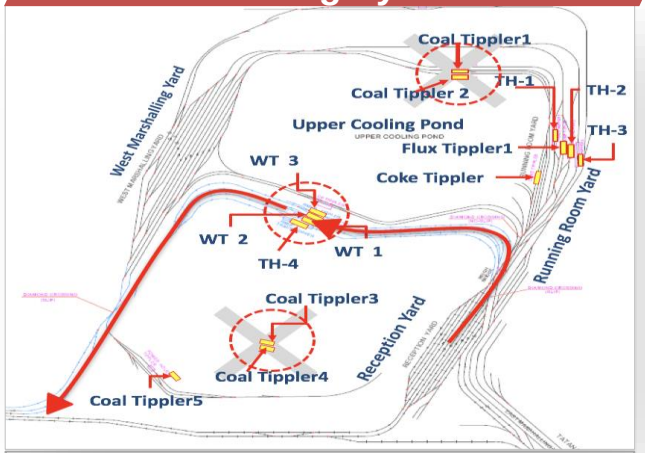
- High demurrage cost
- Low throughput
- Lower equipment utilization
- High turnaround time
- Circuitous layout

Discrete Event Simulation



- Time and motion study
- Congestion analysis
- Discrete event simulation
- Scenario analysis
- Sensitivity analysis

Recommended Raw Matl. Handling System



- Negligible demurrage cost
- High throughput
- High equipment utilization
- Lower turn around time
- Simplified layout

- **Optimization of 18 mil tonnes RM handling capacity**
- **Faster turnaround by reducing number of coal tipplers**
- **30 MM$ of Demurrage cost saved***

* Present Value of 25 years demurrage with no inflation considered

Special Mention:

Coal Gasification – For Energy security and cleaner future

Why Coal Gasification?

- Utilization of Abundant High ash-coal at competitive cost
- Limited oil & Gas Reserves

Syn Gas Usage: Steel Production (DRI) / Chemicals / Urea

Benefits:

- Reduce dependency on Crude & Coking Coal Imports
- Reduction in CO2 Emissions by Carbon Capture

Dastur References: JSPL, HINDALCO

China has > 100 operating Coal Gasification Plants

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