Benefits of Advanced Configuration and Simulation Study

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Dear Reader,

This paper examines the objectives and benefits of a configuration and simulation study in a steel plant with various process and finishing lines. Simulation studies cross-check and verify the operational and financial feasibility and success on real-time basis.

An analysis of a typical case study will be given in this paper to understand the benefits of such an advanced scientific study. Logistics innovations take courage, resources and time — but the payback can be great. This paper provides a look at key logistics developments over the years, what modern steel plants are opting for today, and how to become a logistics innovator to achieve the overall goal of the company and the steel industry.

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The main objectives of a configuration and simulation study in a steel plant with the mother mill and various process and finishing lines, or in a large warehouse are:

- To optimize and rationalize the product’s (coil or sheet packs) logistics and handling within the plant in a safe and economical way.
- To evaluate the potential to cut costs related to the product’s automatic handling, storing, packaging and shipping.
- To boost plant efficiency by removing bottlenecks and adjusting parallel and duplicate operations across the process chain.
- To minimize damages, errors and accidents.
- To discover the convenient phases of implementation of yard management systems (YMS) and warehouse management systems (WMS) to control the overall automatic material movement and production, planning and dispatch.

Such a simulation study would cross-check and verify operational and financial feasibility and success on a real-time basis before conceptualizing and installing the unit, thus avoiding any unnecessary resources, or building or related expenditures.

**Configuration Study**

Material handling is an essential area of a steel plant wherein, for example, the coils are transported from the hot rolling mill to cold rolling mill. Upon receipt and storage, the hot rolled coils are sequentially fed to the pickling and tandem cold rolling mill line at an approximate throughput rate of 10–20 coils per hour in and out. Upon completion of rolling, the coils are received and stored and again distributed to the next operation, for example, galvanizing or continuous annealing, or directly dispatched as cold rolled full hard material. Similarly, at the exit of the process lines, the material is received and routed toward the recoiling line or recoiling and tension leveling line, after which it is taken into the automatic packing lines and then to the delivery storage and dispatch.

The delivery storage could be approximately 2,000–5,000 coils at a time, and the throughput of such storage could be an average of 50 coils in and 50 coils out. To keep the coil transfer and storage system in line with the transition planning norms, a thorough study of the hardware and software requirements per zone is needed, which will represent the configuration of the plant. Thus, the configuration study is a preliminary study, assuming the throughput requirement and the stock keeping units (SKUs) so as to arrive at an optimum solution for sensible material handling, without duplicate handling as well as with minimum bottlenecks.

The configuration study also specifies the automation level for a situation wherein the throughput is high; for example, >15 coils per hour, in which case manual handling and tracking could become a more costly, non-productive and unsafe activity, and well-engineered automation with suitable internal logistics become a better option (Figures 1 and 2). Thus, a configuration study helps in arriving at the mode of material handling system with specification of each hardware required.

*Configuration and simulation study minimizes the investment risks by providing real-time based information at the planning stage.*
Simulation Study

Once the configuration analysis is complete and discussed with the technical group, a basic layout of hardware such as electrical overhead traveling (EOT) cranes, coil cars and other handling equipment, including storage devices like automatic storage and retrieval systems (ASRS), is captured to know the cycle time as well as the quantity of hardware required. A simulation study is essential, in which the EOT cranes and coil cars, as well as the coils themselves, are in movement on a real-time basis through the 3D simulation software.

In this simulation, the parameters can be altered to arrive at the optimum number of cranes, coil cars, storage place area or number of places by simulation of the actual situation (Figure 3). This helps in testing the configuration as well as the resources before actually installing the plant. Simulation study becomes a vital tool for assessing the practical situation and planning the critical paths and critical areas.
Simulation study and preparing simulation layout takes time, but once completed, operation, maintenance and resources for the corresponding productivity and storage inventories become crystal clear for all involved in the project. While there are many options available on the configuration, the simulation study helps to pinpoint the optimum configuration with the resources such as number of cranes, coil cars, people, etc. This avoids duplicate planning or duplicate investment and becomes an essential tool for the project. Consensus among project, operation and maintenance personnel is easily reached based on the scientific simulation.

**Optimization and Rationalization**

A network of production facilities and warehousing sites is best designed with rationalization and optimization, considering the following points:

- Manufacturing cost, inventory cost, transportation cost, packing cost, and time to the respective process lines and shipping facilities and to the warehouse, creates complex web of variables.

- Offers a service that utilizes a mixed integer program to optimize costs with business modeling to ensure high service levels and prompt, in time feeding to the process lines, finishing lines and dispatch system.

- Rationalization is an exercise of carefully segmenting products, supply line, customer lines and allocating activity-based and functional based costs to each segment.

- During the modeling, it becomes evident which combination of hardware, warehouse management system, products and processes are providing a positive contribution and which ones are making a negative contribution based on different parameters like product mix, throughput, physical and metallurgical parameters, etc., and gives an opportunity for the user to select the right type and quantity of hardware and the right type of automation level and program.

- Rationalization is an operations-based examination of the cost and profit contributions of individual items in the functional and asset base.

- Creating the right product mix for consumer preference. This section also focuses on defining and differentiating service levels for a customer/product matrix.

- This work stream focuses on ensuring that the client has an organization that is properly structured, incentivized, and capable of executing the route to distribution and material handling strategy outlined.

- Material handling/design is the art of transforming strategic logistics planning to a disciplined engineering expertise, enabling the optimization of resources to streamline flows of goods.

- Design stage

1) Master plans and conceptual design
2) Detailed design and coordination
3) Tailored packing solutions (Figures 4 and 5).
4) Conventional/mechanized/automated
5) Storage systems
6) Sorting and conveyance
Whenever the problems are complex with multiple interdependencies, modeling and simulation provide the power of “what if” analysis in order to predict the effect of changes on the business before implementation and make the best decisions. It gives the organization the competence to avoid costly mistakes due to decisions based on intuition and to reduce risks to almost zero.

In summary, the benefit equation out of rationalization and optimization for any plant or business is:

**Great value + inexpensive and safe logistics and insurance + excellent planning**

This means adjusting the design to the physical site and building configuration, with systematic, built-in problem-solving features with respect to material handling and transportation.

**Software Solutions**

- Warehouse management system (WMS) or yard management system (YMS).
- Mobile solutions RF, Voice: Voice responsive controls.
- Transportation management system (TMS).
- Bar code and radio frequency identification (RFID) tracking system.

**Cost Savings Analysis**

Performance improvement of manufacturing systems (Figure 6):

- Factory flow
- Capacity analysis
- Production planning and scheduling
- Bottleneck analysis
- Job routing
- Staffing
Performance improvement and logistics/distribution systems:

- Supply chain strategy
- Logistics network optimization
- Warehouse analysis
- Distribution policies evaluation
- Stock levels determination
- Inventory-control mechanisms
- Transportation

Similar analyzing tools are available for internal logistic and storing system.

Figure 6: Typical cost optimization for packing of coils.
How to Remove Bottlenecks

The proper choice of vertical storage system (ASRS) (Table 1) with the warehouse management system ensures a “dispatch/transportation smoothing” feature to its transport routing and scheduling software to avoid bottlenecks in the steel plant feeding system or warehouse dispatch.

Table 1: Advantages of vertical ASRS to avoid bottlenecks

<table>
<thead>
<tr>
<th>ASRS</th>
<th>Traditional Layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space 33%</td>
<td>Space 100%</td>
</tr>
<tr>
<td>Three overhead cranes in each bay (for maintenance only)</td>
<td>Eight overhead cranes</td>
</tr>
<tr>
<td>0-30% workers for logistic/shift</td>
<td>100% workers for logistic/shift</td>
</tr>
<tr>
<td>Automated logistic integrated with production</td>
<td>Operator depending logistic of products</td>
</tr>
<tr>
<td>No human influence on the process</td>
<td>Manual operations influence the production</td>
</tr>
<tr>
<td>56% power cost</td>
<td>100% power cost</td>
</tr>
<tr>
<td>26% running cost</td>
<td>100% running cost</td>
</tr>
<tr>
<td>Error-free deliveries</td>
<td></td>
</tr>
<tr>
<td>Helps increase response time to customer demands</td>
<td></td>
</tr>
<tr>
<td>Automatic order preparation of custom deliveries</td>
<td></td>
</tr>
<tr>
<td>Reduces excessive handling of coils</td>
<td></td>
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<tr>
<td>Inventory can be accurately tracked at all stages</td>
<td></td>
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</tbody>
</table>

Transport plans focus on meeting the individual receiving line demands with available transport resources, but do not generally consider the hardware and resources of the plant or warehouse to feed the system. The Dispatch Smoothing option enables balancing the needs of logistics and warehousing operations by optimizing workflows that improve efficiency by ensuring that all available resources are being used effectively.

The routing and scheduling optimization software, for example, makes it possible to plan the optimized loads for dispatch in a way that enables the plant or the warehouse to easily cope with demand. The software does this by controlling the profile of the loads prepared for dispatch from the warehouse and automating the scheduling of vehicles/coil cars/cranes so that departures within a given period are achievable using the available warehouse resources — people, loading bays and equipment. This Dispatch Smoothing functionality is said to help optimize the route schedules in such a way that these available resources are not overburdened while maintaining material handling service excellence.

To Minimize Damages, Errors and Accidents and Manual Operation

By selecting a suitable handling system, for example four-way or two-way coil cars for handling the coils, the damage to the coils could be minimized far more as compared to handling by the overhead cranes. Similarly, incorporating automation for the material transfer with a proper tracking system and yard mapping, human interface and accidents could be avoided to the maximum extent.

For example, errors in loading a wrong coil (i.e., a thinner material coil) for the process when the annealing furnace is set for a thicker material could be catastrophic, as there could be strip breakage and line shutdown for a prolonged period, causing time, production and profit losses. Similarly, loading a wrong material to a wrong customer is equally as severe. Such errors could be avoided with a suitable tracking system using bar code or RFID with automatic material handling and transportation. Figures 7 and 8 compare the traditional and the modern flow.
Traditional Mill Logistic:

- Processes automated and efficient but no overall control of material flows.
- Storage and buffering functions are often isolated operations.
- Capital tied to raw materials, and intermediate products are excessive.
- Manual operations may still control the process, even in a fully automated production line.

Figure 7: Traditional layout with many bottlenecks.

Figure 8: Automatic material handling and ASRS concept.
Automation and YMS Configuration Study: A Convenient Staircase?

Automation in material handling and a complete automatic yard management system is normally a staircase where the plants or warehouse with a brownfield project plan to upgrade their material handling and feeding and distribution system. Whereas for a greenfield project, the appropriate level of automation and yard management system could be chosen on day one with corresponding skilled workers and minimum operators and engineering resources (Figure 9).

<table>
<thead>
<tr>
<th>STEP</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Define scope of the study</td>
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<tr>
<td>2</td>
<td>Initial data of the mill existing operations</td>
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<td></td>
<td>Evaluation of data</td>
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<td></td>
<td>Summary of interviews and mill visits</td>
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<tr>
<td>3</td>
<td>Ideal plant layout</td>
</tr>
<tr>
<td></td>
<td>Layout for logistics arrangements and packing lines</td>
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<tr>
<td></td>
<td>3D animation and engineering data of the increased production capacity</td>
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<tr>
<td>4</td>
<td>Comparison of different technologies</td>
</tr>
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<td></td>
<td>Transportation and conveying systems</td>
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<td></td>
<td>Automated storage versus manual handling with overhead cranes and fork lifts</td>
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<td></td>
<td>Manual packing versus automatic packing and material consumption</td>
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<td></td>
<td>Operational cost calculations samples versus existing</td>
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<tr>
<td></td>
<td>Safety features of modern technology</td>
</tr>
<tr>
<td>5</td>
<td>Facts and figures used as basis of this study</td>
</tr>
<tr>
<td>6</td>
<td>Executive summary</td>
</tr>
<tr>
<td>7</td>
<td>Budget proposal and investment payback calculations</td>
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<tr>
<td></td>
<td>Estimated total investment cost divided for 5 years</td>
</tr>
<tr>
<td></td>
<td>Estimated total payback calculations</td>
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<td></td>
<td>Old versus new recurring operational costs</td>
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</table>

Figure 9: Systematic steps for configuration and simulation study.
Summary

1. A simulation and configuration study is a cost effective means of checking and configuring the plant layout, considering both the process line features and the material handling features and carefully integrating them together toward best efficiency.

2. A configuration study not only covers the layout, but also deals with the individual lines’ in-feeding and out-feeding systems with appropriate storage areas and system, along with the way the product is packed and handled before being shipped to the customer.

3. Except for the proper process line and finishing line operational features, the configuration study addresses the throughput right from the mother mill until the finishing storage to dispatch to customer.

4. The findings of the configuration study are crosschecked by real-time simulation with simulation software packages so as to arrive at the best capacity of the hardware (material handling equipment like cranes, coil cars, transfer cars, conveyors), building area, types of storage, cycle time and throughput adequacy.

5. A simulation study that simplifies the layout and resources by avoiding any duplication and over-design, means real cost savings.

6. It is suggested in this paper that, in addition to having a traditional feasibility study of the project based on the marketing aspect and process aspect, it is quite profitable to assess the configuration study and simulation study to ensure smooth material movement. This would be of immense use for ensuring safety and enhanced productivity to achieve the business’ ultimate goal — namely, consistent profitability.

Figure 10: Typical 3D cold rolling mill layout with the process lines and shipping ASRS.