IBM Global Business Services

Driving Efficiency By Optimizing Core Processes in Steel Production

Leveraging powerful optimization technology to achieve levels of performance not thought possible before

Industrial Products Industry

As an asset-intensive industry, the steel industry is under continuous pressure to reduce costs, increase throughput, and achieve higher flexibility to respond to its customers and increase the return on capital employed. Painful price pressures, filling rush orders, and keeping fixed-cost production facilities steaming along are business-as-usual in the industry. While most of the steel producers still use simple tools such as spreadsheets to schedule their production facilities, smart business leaders are looking to improve their operational efficiency. By adopting more sophisticated approaches to optimize their scheduling and production designs, steelmakers can better raise the bar in efficiency and effectiveness levels.

Improving core processes through optimization is a key opportunity. In the most common current states within the steel industry, manufacturing represents the largest opportunity for improving core processes.

I. Effectiveness is an imperative for a dynamic industry

The steel industry has rejuvenated recently, with consolidation making most of the headlines. Globalization and growth also generate most of the news within the industry, and for good reasons. One out of five top-producing steel manufacturers now has operating profit margins of over 20%, up from only one out of 25 just five years ago. World production has climbed 50% since 2001, and world usage is following close with expected 50% growth between 2001 and 2010[1].

At first glance, this growth appears sunny. Still, four out of five top-steel producers lag with operating profit margins under 20%. The rash of consolidations shows an industry trying to reconcile its costs and market-share. Labor and other operating costs still account for 27% of steelmaking costs on average (hot rolled coil)[2]. The drive to get bigger and better is felt throughout the industry.

CEOs and their teams know that they need to get better operationally. According to the IBM CEO study, the top reasons for change in operations are driven by customers (62%), new science and technology (54%), and technology automation (45%). "Improvements to core processes" is also emerging as a top reason[3], with 45% of CEOs naming it as a priority. To put these top challenges together may define a major part of the operational agenda for steel manufacturers: "How can we improve core processes using technology and optimization to increase competitiveness and better serve our customers?"

Improving core processes through optimization is a key opportunity. In the most common current states within the steel industry, manufacturing represents the largest opportunity for improving core processes. At the same time, many of the core manufacturing processes are left to outdated planning approaches, and often depend on the expertise of the production personnel. The performance of these practices can change from shift to shift, and a plant's ability to maintain expertise can be as volatile as a sick day or an aging worker's retirement.

Most companies have invested millions of dollars in Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES), but few have adopted more sophisticated tools capable of closing the gap and eliminating the weakest link between these two critical applications.

While there has been some ad hoc system creation to address these issues, most in-house systems are still conducted through simple tools or spreadsheets that rely largely on the operator's experience and require considerable manual intervention. The reliance on these simple tools characterizes a peculiar weak link in steel manufacturing operations management. On the other side, most companies have invested millions of dollars in Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES), but few have adopted more sophisticated tools capable of closing the gap and eliminating the weakest link between these two critical applications.

Using spreadsheets or other simple mechanized approaches brings inherent barriers and challenges that steelmakers experience on a daily basis. They include:

- Disconnects between the plan and execution: putting together a plan or a schedule requires significant effort to generate a single feasible solution. Manufacturing variability, such as quality problems or equipment breakdown and changing business conditions, such as the need to process a rush order, require continuous adjustments in the schedule that are usually left to the production personnel to try their best.
- Operations in silos: while everyone is trying their best to optimize their part of the process, the overall throughput of the company requires a broader view of the production constraints, coordination between upstream and downstream operations, full visibility of the entire order book and available inventory, including the specifications of each order and actual characteristics of each piece of metal, etc. Lack of global visibility and better-synchronized operations generally inflates lead-times, impacts on-time delivery and drives a higher operational cost.
- Complexity of steel manufacturing: the scheduling of the melting shop operations is a critical task for any steel maker and it directly impacts how well the facility is operating. Several optimization objectives need to be considered simultaneously, including, for example: maximize caster up time, maximize tundish life, minimize grade transition, minimize width changes, maximize on-time delivery, etc. The schedule should consider the balancing of the pig iron supply from the blast furnaces, and a large number of physical, metallurgical constraints and other business rules.

The impact of properly managing the intangible practices can be a clear path towards better client delivery, better yield, better margins, competitiveness, and ultimately profitability.

The inability to effectively manage these processes results in poor operations performance. From a revenue perspective, these shortcomings can create customer satisfaction issues, such as delays in delivering orders as promised, lack of flexibility or even poor quality. In the worst-case scenarios, plants can suffer production stand-stills and gross under-utilization of fixed cost assets and resources. From the market's perspective, the worst case may include higher product prices, less competitiveness, and profit reduction.

Looking to best practices and sophisticated optimization for a better way forward

The impact of properly managing the intangible practices can be a clear path towards better client delivery, better yield, better margins, competitiveness, and ultimately profitability. To achieve this, steelmakers must stop leaving these practices in undeveloped, reactive, organically-grown states that rely on individual operator expertise and heroic work-arounds. These practices must be aggressively formalized, so that results are not left to chance, procedures are not invented on the fly, and decisions not made without access to information.

The first step in a transformation towards properly leveraging intangible practices is overcoming the shortcomings of the current processes. The corrective actions needed include:

- Establishment of a manufacturing discipline, best practices and supporting metrics that enables the company to focus on maximizing the throughput and profitability of the entire company
- Establishment of a plan or schedule process that drives the execution of production orders in the most cost-efficient way, enabling the company to react to manufacturing variability and changing business conditions in the most effective way, thus minimizing disruption
- Adoption of tools that provide global visibility, break the silo-based operations, or provide forward views to potential problems by extending the scheduling horizon from hours to days or even weeks – a detailed view of potential problems that could be avoided if known with enough time in advance

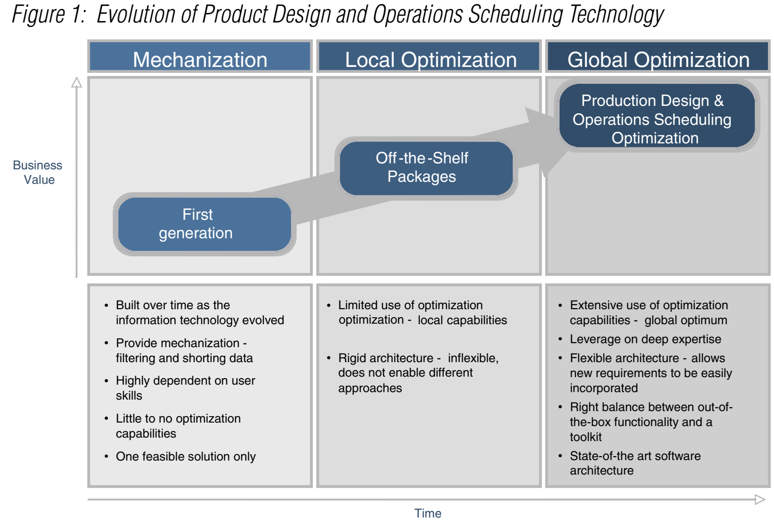
The field of applying Operations Research (OR) in production design and operations scheduling has evolved significantly during the last decade. However, most steel companies still operate at a relatively low level of maturity.

A majority of these corrective actions can be handled through leading edge production design and operations scheduling optimization solution. Using software and data, complexity can be organized, visibility achieved, and scheduling optimized. At the same time, shifts in behavior, knowledge and processes have to be applied by the management and staff in order to understand and employ a best practices approach to these issues.

The field of applying Operations Research (OR) in production design and operations scheduling has evolved significantly during the last decade. However, most steel companies still operate at a relatively low level of maturity. We can break down the evolution of this capability into three categorical phases as shown in the diagram below.

While many companies remain in a 'mechanization' phase of maturity, some have moved into or are considering adopting off-the-shelf packages. While this path is an improvement when compared to homegrown spreadsheets, off-the-shelf solutions often lack the flexibility to address the specific needs of each steel producer and just provide a local optimization. The most benefit can be realized through the adoption of more powerful optimization techniques through a production design and operations scheduling solution that provides not only the flexibility needed to meet the specific requirements of each steel producer, but also the global optimization capabilities required to achieve a level of efficiency not thought possible before.

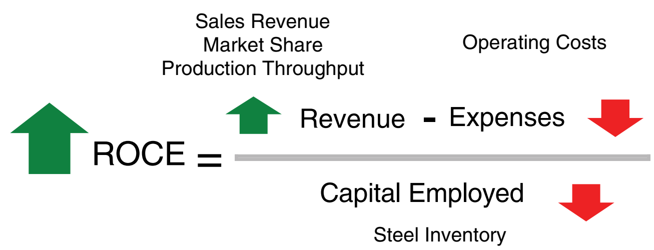
Figure 1: Evolution of Product Design and Operations Scheduling Technology



The case for production design and operational scheduling optimization will ultimately come from the bottom-line benefits it delivers as much as from the problems it solves. In the capital-intensive arena of steel manufacturing, return on capital employed (ROCE) may be one of the most valuable measures.

The case for production design and operational scheduling optimization will ultimately come from the bottom-line benefits it delivers as much as from the problems it solves. In the capital-intensive arena of steel manufacturing, return on capital employed (ROCE) may be one of the most valuable measures. The diagram below shows a simple understanding of this metric:

Figure 2: Return on Capital Employed (ROCE)



If we think of a typical (and hypothetical) steel manufacturer, they may have a five million ton capacity, $750/ton average sales price, $3.75 Billion in revenue and $3 billion in asset investment. They may be spending 16% of their costs on operations. By relying on their “simple tools or spreadsheets”, they could be missing opportunities to reduce operating costs by 2 to 20%, reduce inventories by 5 to 40%, increase production throughput by 2 to 5%, and increase revenue by 2 to 5%. For example, a reduction of 4% in operating cost to produce slab can result in a $3 per ton benefit, helping our hypothetical steel maker to save $15 million per year in added margin. An $8 per ton improvement is $40 million in new margin. ROCE is directly impacted.

Steel leaders must be able to set and prioritize the operational vision for their plants. They will have to decide whether they are married to the "old way" and will continue to rely on their staffs' instincts and spreadsheets, or whether they will look to new and better practices to drive effectiveness in their operations.

Listed below are some of the benefits achieved with global optimization enabled by production design and operations scheduling.

Figure 3: Benefits of Global Optimization enabled by Production Design and Operations Scheduling

Process area	Increase Productivity	Increase Revenue & Market Share	Reduce Operating Costs	Reduce Inventories Inventory Application
Inventory Application	Better utilization of capacity	Reduce lost sales through better inventory search	Minimize rework considering route compatibility	Reduce unused weight and waste
Slab Design	Maximize average slab weight	Higher flexibility to handle smaller orders	Higher manpower productivity	Reduce slab inventory due to better designs
Plate Design	Minimize number of plates to fulfill orders	Improve ability to fulfill high priority orders	Minimize cutting waste and surplus	Reduce plate inventory due to better designs
Melting Shop Scheduling	Higher caster up time	Faster responsiveness to customer inquiries	Minimize waste due to grade transitions	Reduce surplus due to better cast/ charge design
Hot Mill Scheduling	Higher hot charging ratio	Higher quality due to less radical gauge & grade changes	Reduce hauling costs – slab yard & hot mill	Reduce WIP due to better synchronization
Finishing Line Scheduling	Better production flow due to higher synchronization	Improve on-time delivery	Higher flexibility to cope with unexpected situations	Reduce finished goods inventory due to better delivery performance

The projected benefits should be enticing enough to prompt operational leaders to take a long and serious look at their current state of maturity in core process optimization. Steel leaders must be able to set and prioritize the operational vision for their plants. They will have to decide whether they are married to the "old way" and will continue to rely on their staffs' instincts and spreadsheets, or whether they will look to new and better practices to drive effectiveness in their operations.

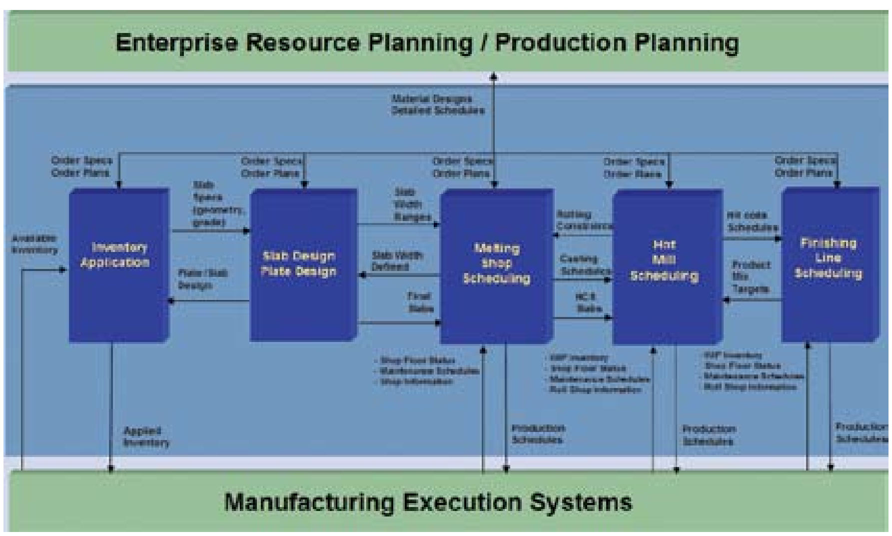
In a new approach, inventory and order management have visibility and interaction with all phases of production planning, the ability to build more sophisticated and creative scheduling plans, and ultimately enables the manager to view and manage the entire production process.

II. Optimizing Core Processes: Production Design and Operational Scheduling System

Arguably, the greatest gaps in achieving global optimization during the steel production process are not so much shortcomings in any one discipline, but the lack of visibility, coordination, and standardization among many disciplines. This said, to achieve optimization, the new approach must solve for visibility and coordination across and between the disciplines. An advanced production optimization solution can enable this visibility and coordination in ways not possible with a traditional approach. A strictly linear flow to the production process rears the same results as a lack of visibility or coordination. In a strictly linear flow, inventory planning is done first, then slab design, then melting shop scheduling, etc. This allows for very few changes once set in motion and doesn't allow for variability in planning. In a new approach, inventory and order management have visibility and interaction with all phases of production planning. This allows for greater responsiveness, more variability in planning, the ability to build more sophisticated and creative scheduling plans, and ultimately enables the manager to view and manage the entire production process.

Listed below are six areas of the steel production process and a description of the opportunity for improvement through an advanced production optimization solution.

Figure 4: Applying Advanced Optimization to Steel Production



A new view: sophisticated inventory application enabled by advanced analytics and optimization. With a click, the entire order book is checked against the inventory in the best possible way, matching the sizes, shape, grade, finishing specifications, etc.

A. Inventory application - matching inventory to orders

Maintaining inventory is expensive. It represents cash on the floor – money that could be working elsewhere. It takes up space, it requires resources to manage, too much can drive waste, too little can result in lost sales. These competing imperatives define the challenge for the inventory manager.

Making matters worse, the complexity of the steel business imposes complicating factors that add to the problem. Materials in inventory are not specified by stock keeping units (SKUs), but by a set of characteristics or attributes. Orders are specified by a set of specifications and for each specification an acceptable range is usually defined. The detailed analysis of each one of these attributes is required when doing the matching.

Leaving this to be done in old systems or in the minds of a few experts often relies on intuition instead of an optimized system. This results in orders being filled on a 'greedy' first-fit basis leading to suboptimal inventory usage, excess waste, and inefficient order completion. A conventional approach to this process is hindered by serious value inhibitors such as:

- The high number of attributes to consider and whether there is a straight and non-straight matching, resulting in complex matching problems
- A lack of optimization, limiting the ability to find, among all the possible alternatives, the best materials to fulfill the orders
- Limited visibility of the total available inventory across the entire plant, being either finished good or any other work-in-process material
- Informal processes that depend on the experience of individual operators

A new view: Sophisticated inventory application enabled by advanced analytics and optimization

With a best-in-class production optimization solution, the inventory manager would have at his fingertips a live view of all existing inventory across the entire mill, from casting through to finished goods. With a click, the entire order book is checked against that inventory in the best possible way, matching the sizes, shape, grade, finishing specifications, etc. Additional processing steps are assigned to multiple unfinished inventory pieces to satisfy a single order, while orders that are only partially filled

A state-of-the-art slab design system helps cut production costs by reducing the number of slabs that need to be produced to fulfill a give quantity of orders. By maximizing the average slab weight, continuous casters are able to operate at their highest capacity.

from the inventory are completed by addition to the production schedule. Multiple order assignments are applied to one or more items of inventory, allowing smaller orders to be fulfilled rapidly while reducing waste. Rush orders are directed to work-in-process and surplus inventory on the fly. The benefits of such a system are apparent:

- Mill productivity is increased due to better utilization of capacity
- By considering route compatibility, handling and rework of materials is reduced along with operating costs
- Inventory utilization efficiency is higher, with less unused weight and waste
- Fewer sales are lost due to better inventory search, improving revenue and market share

B. Slab design

Whether the steel is destined for processing into plates or coils, slab design is a crucial step in meeting order requirements while minimizing the surplus material production that often occurs during steel production. Beyond just meeting the requirements for the width, weight, grade and quality of the slab, the design also has a direct impact on the operations of the casters, especially when caster capacity is a bottleneck.
Sub-optimized slab design: a source of loss in the steel mill

The limitations of many commonly used procedures for slab design introduce unnecessary costs to the steelmaking process. For instance, utilization of "standard" slabs that doesn't take into consideration individual order requirements can lead to surplus inventory and the associated cost and space constraints. The design of slabs taking into account order by order requirements can lead to unnecessary surplus and waste, resulting in a low average slab weight that can impact the total mill throughput. A limited ability to assign multiple orders to the same slab can also result in the lack of ability to accept small orders.

Software-assisted slab design

A state-of-the-art slab design system helps cut production costs by reducing the number of slabs that need to be produced to fulfill a given quantity of orders. By maximizing the average slab weight, continuous casters are able to operate at their highest capacity. A key feature of such a system would be an ability to assign multiple orders to the same slab. This system should be an integral part of the cast design process.

A best-in-class production optimization solution would design mother plates by considering the entire order book simultaneously. These designs would maximize yield and average slab weight while minimizing the number of mother plates required to fulfill customer orders.

The benefits of such a system include: increases in productivity with higher average slab weights; higher sales & revenue due to greater flexibility to handle smaller orders; and reduced operating costs and inventories as a result of higher productivity and less surplus.

C. Plate design

The production of the heavy plates used in applications such as shipbuilding and construction is closely tied to mother plates and slab production. It starts with an order book of plates that need to be produced and tackles the problem of packing those orders into the minimum number of mother plates that satisfy guillotine and materials constraints. The solution should also explore all the potential plate widths a given mother plate could produce to find solutions that would maximize yield, average slab weight and on-time delivery.

Challenges in the plate design process

In addition to being a time consuming process, the traditional manual method of plate design has numerous potential value inhibitors:

- Cutting plans are not optimized, resulting in avoidable waste
- Placing urgent orders into the production schedule increases waste and delays orders already in process
- Constraints mandated by upstream and downstream processes are not fully considered
- During the casting process, the design of slabs does not always fit the plate requirements
- In multiple mill operations, deciding which mill to use for producing plates is not optimized

An automated process for plate design

A best-in-class production optimization solution would solve these problems by designing mother plates by considering the entire order book simultaneously. These designs would maximize yield and average slab weight while minimizing the number of mother plates required to fulfill customer orders. For example, plate designs can be generated in either simple or mosaic cutting patterns, depending on the mill's cutting capabilities. The best yields within an operation's gas cutter or cooling capacity constraints would be met.

When an optimized production schedule is generated, the melting shop can increase throughput, reduce the amount of inventory being generated, lower operating costs, and provide steel companies with greater flexibility to cope with urgent orders and unexpected disruptions in production.

In addition, the software application should allow for continuous optimization and filling of new orders as they are placed, while still being easy to implement through open standards architecture and a Web-based graphical user interface, which enables rapid deployment and a low total cost of ownership.

Multiple benefits can be gained from such a system. Mill productivity can be increased with fewer mother plates required to fulfill orders. Backlog can be reduced. An improved ability to fulfill high-priority orders can bring a competitive advantage. All the while, better designs result in lowered costs due to less cutting waste, surplus, and inventory.

Integrating slab and plate design

For even higher optimization and efficiency, the plate and slab design applications should work together to make further efficiencies in plate design and mill productivity possible. By examining the order book of plates it's possible to determine the optimal sequence and dimensions of the slabs and mother plates that need to be produced – satisfying delivery requirements, maximizing yield, and minimizing surplus and waste.

D. Melting shop scheduling

Running an efficient melting shop operation requires the generation of production schedules from the steel making facilities, such as blast furnaces or electric arc furnaces to secondary refinement to the continuous casting. When an optimized production schedule is generated, the melting shop can increase throughput, reduce the amount of inventory being generated, lower operating costs, and provide steel companies with greater flexibility to cope with urgent orders and unexpected disruptions in production.

Melting shop scheduling challenges

The complexities of coordinating the continuous supply of hot metal from the blast furnaces, managing all of the applicable production and metallurgical constraints, and facilitating the on-time delivery of the orders can lead to inefficient utilization of production assets resulting in:

- Excessive grade transitions within a given cast
- High number of turnarounds and caster downtime
- Production of excess inventory and secondary materials
- Lack of coordination between the caster and hot mill
- Low tundish life utilization
- Poor on-time delivery performance, just to name a few.

Processing slabs into hot coils demands coordination across the casting operations, slab yard, reheating furnaces and hot strip mills. Despite the extensive experience of the experts, doing it manually or with a tool that does not provide the required capability to explore all the possibilities can still lead to inefficient utilization of production assets.

Software-driven melting shop scheduling
Optimal scheduling of melting and casting operations can be achieved through an advanced production optimization solution. Such an approach would begin with a set of slabs needing to be produced to fulfill the order book. These slabs should be grouped into casts (or tundish lots) and the casts should be sequenced across all the continuous casters as well as the upstream processes, such as melting and refinement. Such a solution enables the steel company to:

- Maximize tundish life and caster up time
- Minimize grade transitions and width changes
- Minimize the use of surplus or stock slabs
- Maximize on-time delivery of the orders
- Maximize synchronization between casting and hot rolling

Benefits realized by such a system include increased throughput – volume of sellable products and reduced operating costs.

E. Hot mill scheduling
Processing slabs into the hot coils demands coordination across the casting operations, slab yard, reheating furnaces and hot strip mills. Doing it right means generating optimal sequences of slabs to be rolled in the hot strip mills, as well as coordinating the utilization of the reheating furnaces. It also requires taking into account the supply of the hot slabs coming from the caster and considering slab yard hauling constraints. The sequencing of the slabs in the hot strip mills should follow not only the coffin profile from a width pattern, but also follow many other factors and should have smooth gauge and rolling temperature transitions. Value inhibitors of hot mill scheduling

Despite the extensive experience of the experts who perform the scheduling, doing it manually or with a tool that does not provide the required capability to explore all the possibilities can still lead to inefficient utilization of production assets resulting in:

- Shortened roll life
- Excessive gauge changes
- Low productivity due to partial rounds and re-heating requirements

Maximizing the hot charging rate is the best way to keep reheating costs low, but the constraints between continuous casting and the hot mill processes make it a daunting task.

Furthermore, a lack of synchronization between the casting and hot rolling operations leads to additional re-heating costs for the slabs, reduced productivity of the hot mill operations, higher level of inventory, increased production lead-time and delays in meeting order deadlines.

Optimized hot mill scheduling

An advanced production optimization solution for hot mill operations should be capable of considering all the slab yard, synchronization with casting, re-heating furnaces, and hot rolling constraints, including proper width and gauge profiles which should be incorporated to minimize wear on the roller surfaces, maximizing their life span and keeping productivity up. Furthermore, it should be able to handle any combination of cold, warm, hot and direct hot charging and optimize across several objectives, such as: maximize utilization of the rolls, maximize on-time delivery, minimize gauge transitions, etc.

Synchronizing casting and hot mill operations

Maximizing the hot charging rate is the best way to keep reheating costs low, but the constraints between continuous casting and the hot mill processes make it a daunting task:

- Continuous casting minimizes the number of width changes, but the hot mill has to follow a width profile
- While casting minimizes the grade change in a strand, the hot mill can accept multiple grades of similar hardness
- Gauge is the key consideration in creating a round sequence for hot rolling but is irrelevant in continuous casting

Additionally, quality and other metallurgical conditions may impact the percentage of slabs that are eligible for hot charging.

F. Finishing line scheduling

Certain customers, particularly those in auto manufacturing, have strict requirements for product quality and on-time delivery. Constraints across production units should be carefully considered when setting up the scheduling of the cold rolling and finishing line operations to process coils to meet customers' final specifications for dimension, surface finishing, mechanical properties, and coating:

Constraints across production units should be carefully considered when setting up the scheduling of the cold rolling and finishing line operations to process coils to meet customers' final specifications.

- Width profiles of the strips, to minimize trim loss and scarring of subsequent coils
- Grade of the products, to keep high-grade steel from being processed too soon after downtime but before the rollers wear down
- Differences in thickness and width of consecutive coils to maximize weld strength
- Minimizing setup changes in production campaigns

Finishing line challenges

The complexity of the factors involved, when combined with working within due date constraints, balancing between multiple process flows, considering the specific constraints of each production unit and figuring out the sequencing and duration of the production campaigns to synchronize the flow of production across several facilities, can challenge even the best-trained scheduling experts. Unfortunately, human-designed campaigns are based on a test of best guess and are somewhat static, being limited to horizons of several days. As a consequence they often generate:

- Insufficient synchronization between facilities and materials, causing a high level of work in process inventories
- Excessive setups affecting capacity or causing delays
- Increased production lead time which impacts due date performance

Software-optimized finishing line scheduling

An ideal system for scheduling the cold rolling and finishing lines should incorporate a combination of techniques to address this complex problem and generate a high quality solution that could optimize the entire production process. First, the best grouping of coils and optimal sequence of the resulting groups are sought. Then, within each group, coils are sequenced for more efficient processing.

With the ability to create one-month production schedules, such a system would give users an accurate view of on-time delivery performance, with greater flexibility to handle unexpected situations.

Furthermore, upstream processes would take into account the amount of WIP required at downstream processes, thereby improving overall production throughput and due-date performance. At the same time, downtime for maintenance must be coordinated with the amount of WIP to reduce overall impact, and all of this needs to be done collaboratively with inputs from human experts.

With the ability to create one-month production schedules, such a system would give users an accurate view of on-time delivery performance, with greater flexibility to handle unexpected situations. Properly supplied materials from upstream processes would reduce unplanned downtimes, while reducing setup costs and improving coil quality. Lead times would be shortened due to consideration of upstream and downstream production campaigns, enabling better control of WIP due to a tighter synchronization across the entire line.

The most recurrent themes in building best-in-class steel production planning and scheduling processes is to not remove the experts from decision making, but to provide the tools that allow them to better utilize their expertise and time.

III. Making the transformation

The most recurrent themes in building best-in-class steel production planning and scheduling processes is to not remove the experts from decision making, but to provide the tools that allow them to better utilize their expertise and time. These tools will enable them to analyze different alternatives and business scenarios and come up with the best alternative for their operations as quickly as the business need dictates.

However, a software program can only take an organization so far. The adoption, training, and use of the software, as well as its integration into the organization (both technologically and culturally) will determine its overall success. The success of such a system will rely on how it is deployed and used, enabling the execution of a more efficient business process.

Steel companies considering taking the first steps towards adoption of better production planning and scheduling processes should undertake some critical activities to ensure their initiative becomes a strategic and valuable productivity enabler and not an underutilized software launch that is never properly adopted. These activities include:

- Develop an understanding of the current state of operations, including the level of maturity of the 'intangible' practices and their relative cost to the organization.
- Evaluate the current expertise and skill sets of key operators to understand how they perform their jobs, how skills and knowledge vary across units, and how their participation affects the greater productivity of the plant(s).
- Understand software and technology options for production design and operational scheduling. Chances are you already have some older systems in place, and may even have your eye on some packaged solutions that have enticing promises. Take a complete view of the software options available, especially consider tools that incorporate the evolution of advanced optimization and software architecture.
- Develop an operational blueprint and roadmap that shows the operational vision for improvement and a practical, multi-phased approach for achieving it. Use it as a tool for solution selection and bringing the organization on board.

Steel companies considering taking the first steps towards adopting better production planning and scheduling processes should undertake some critical activities to ensure their initiative becomes a strategic and valuable productivity enabler.

- Build consensus and advocacy among key operational leadership to make the change. Organizational commitment is necessary to see the improvement through to the end.
- Develop a numbers-driven business case that shows projected costs and benefits. Use qualitative as well as quantitative measures. Comparing current state to the new state may be tricky, as many of the displaced or mitigated costs will be non-system attributes. Be sure to calculate the entire cost of ownership for the new system.
- Understand and plan for training and knowledge management programs to support the shift. Communications and change management will be necessary for the program to be adopted and successful in the long run.

Figure 5 Some of the Results Achieved with Production Design and Operations Scheduling

Optimization of the steel making and hot rolling operations

- Increased production throughput (volume of sellable products) in about 4$
- Reduced operating costs by about $5/ton (approximately 7% operating cost reduction)

Optimization of cold rolling and finishing lines

- Reduced lead time and WIP inventory
- Increased line productivity by more than 500 tons/month
- Improved on-time delivery from 80 to 95%

Optimization of the slab design

- Increased slab weight by 10% average
- $1M/year savings for every 1 ton increase in average slab weight
- Improved flexibility, enabling handling of smaller orders

Optimization of inventory application

- Better utilization of available inventory - reduce unused weight and waste
- Improve customer service- better ability to fulfill rush orders
- Estimated cost reduction in $1M/year

Conclusion: A Compelling Case for Change

Leaders in steel production understand they must look for new levers to get more from their steel-producing fixed assets. Levers such as the adoption of advanced software tools, as in production design and operations scheduling, which can provide new opportunities for improving core processes and margin control. By using a new approach that uses advanced optimization techniques, steel producers can achieve improved visibility and coordination across the entire steel manufacturing operation, and better flexibility to deal with inventory, orders and unexpected situations. Ultimately a better approach means better ROCE and better business: more productivity; better margins; and improved competitiveness.

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Produced in the United States of America
01-08

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GBW03013-USEN-00