Application of material flow software in BSE consulting services

Since 2000 Badische Stahl Engineering (BSE) has applied the simulation program Pro Model as a supporting tool in layout preparation for new steel plants as well as for solutions in case of material flow bottlenecks in existing steel plants. With this tool it is possible to realistically visualize and analyze the entire material flow in the steel plant from the scrap yard to the finished product and develop optimal solutions. By means of a representation of different alternatives the best possible material flow can be virtually determined and clearly displayed.

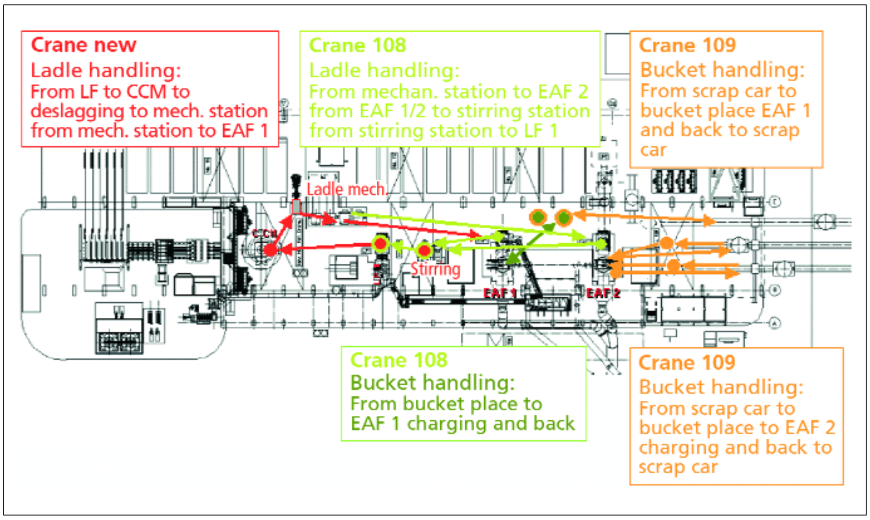

Figure 1. Work assignments for cranes serving the furnace and casting bay

First of all the causes for **material flow bottlenecks** occurring in existing plants and after the implementation of a production increase must be investigated in detail and possible proposals for solutions elaborated. Now the new material flow can be exactly simulated on the basis of the modified layout proposal. This can also be done only for parts of the steel plant. One example is the optimization of ladle handling in a facility featuring complex secondary metallurgy operations, two electric arc furnaces and two casting units but only one ladle furnace.

In case of the installation of new steel plants the design of the best possible material flow, i.e. the optimum layout including the dimensioning of the crane units to be installed, has priority. In most cases basic errors in the layout are irreversible and cause higher transportation costs or limit productivity day after day. Examples for this can be found worldwide more than enough: scrap yards are too small, the installed crane units are too weak or located at an unfavourable position with regard to the melt shop, etc. The complex problem of an optimization of the material flow can be explained more easily by means of the simulation and it is possible to illustrate the problem to an audience without any detailed knowledge of the situation.

Preparation of a simulation

For the construction of new steel plants a layout drawing is prepared as a first step, taking into consideration all logistic parameters starting with the supply of raw materials and consumables up to shipping of the finished product. The aim is to design the material flow in such a way that the planned productivity (t/h) can be achieved safely in consideration of external and internal boundary conditions. The layout and the selection of the correct means of transportation must lead to minimized costs for transportation and storage. For a simulation of existing plants all relevant data are collected in an on-site investigation and are then incorporated in our model.

In both cases, the simulation is based on existing, machine-readable scale layout drawings. The simulation then shows the material flow for the planned productivity and reveals bottlenecks. The advantage for the user is that the specific conditions of *his* individual plant are directly integrated and considered. The same is applicable to the material to be transported, such as scrap buckets, ladles, billets etc. Up to now the layout representation has been done in 2-D format. If the respective layout format is

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Simulation run without peak time		Run 1-2 EAF 1	EAF 2	Run 3 EAF 1	EAF 2
Turn-around	(min)	2.0	2.0	1.5	1.5
Charging 1st bucket	(min)	3.0	3.0	2.5	2.5
Melting 1	(min)	17.7	17.7	16.5	17.7
Carging 2nd bucket	(min)	3.0	3.0	2.5	2.5
Melting 2	(min)	7.4	7.4	7.1	7.4
Refining	(min)	12.8	14.3	12.6	12.8
Tapping	(min)	2.5	4.0	2.5	4.0
Tap-to-tap time	(min)	48.4	51.3	45.2	48.4

Table 1. Excel input table for furnace operation mode

available, a 3-D representation is also possible.

The next step is to describe exactly the transportation tasks of the used operating resources – mainly cranes – to be simulated, taking into consideration the operational sequence, possible priorities as well as a multitude of further logic conditions. The work assignments of the cranes and other transportation means must then be linked to the clocking process step (e.g. electric arc furnace) with the upstream process (e.g. scrap yard) as well as with the downstream units (e.g. ladle furnace and vacuum unit up to the casting unit **(figure 1)**. A link to the rolling mill, for example, for simulation of hot charging would also be possible at a later date.

An advantage is that all parameters of the simulation can be input via an interface into Excel. Due to this input method it is possible to quickly check individual optimisation steps like, for example, a reduction in power-on time and show future production bottlenecks **(table 1)**.

Results of the simulation

A simulation run with a freely adjustable total running time and infinitely variable animation speed can be presented. After termination of a simulation run the utilisation rate of the used operating means is depicted in absolute values or in the form of a diagram, showing whether the operating means are operated at full capacity or if they are maybe overburdened. The maximum number of heats achieved in the simulation period is compared to the theoretically possible number of heats (without material flow bottleneck). The reverse is, however, not admissible. A low total utilisation rate of a crane, for example, does not automatically mean that this crane is not a bottleneck. It can still thwart the process flow from time to time, as it has to handle several tasks in parallel, thus resulting in delays.

All simulated process sections are intermediately stored in a database for a further detailed bottleneck analysis and are then represented via an interface to the Graneda Dynamic Graphics Software as time-travel diagrams **(figure 2)**. In this representation, each individual process step can be reproduced. In case of material flow bottlenecks, these are marked as red bars. After a detailed cause analysis the model can be modified accordingly without any difficulties and possible optimized alternatives for a trouble-free furnace operation can be determined. The present example reveals that there are almost permanent delays, i.e. a "waiting ladle" at EAF 1 before tapping.

Time requirements. According to the complexity of the task we will need approx. 10 to 15 working days on site up to the representation of the solution and its simulation, including the determination of the basic data on site. Based on the experience with previous projects a basic program was developed allowing for an even faster representation of the solution. ■

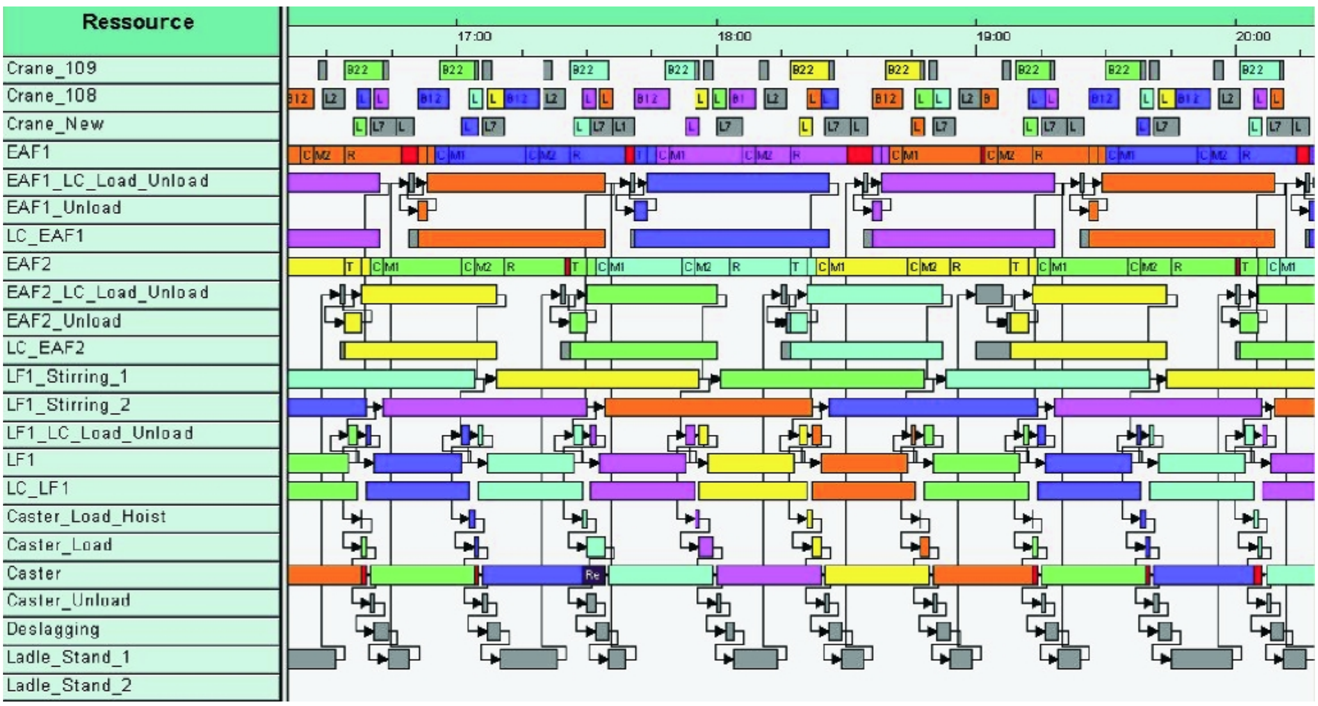

Figure 2. Representation of results in a time-travel diagram / process analysis