



Compact strip production (CSP) in Gallatin County, Kentucky started in 1995

A common language for all data

Gallatin Steel is using the quality execution system from QuinLogic to make coil grading decisions by way of an automated process. Since the installation of the system, it has unveiled countless instances of customer-specific requirements that could have been overlooked without it and that could thus be corrected prior to shipping the coils. The system is currently releasing 75% of all rolled coils automatically which require no further follow-up.

Gallatin Steel in Ghent, Kentucky, USA, is a minimill with an annual hot strip output of approximately 1.6 million tons. Production route mainly comprises an EAF meltshop with ladle metallurgy facility and a CSP thin-slab casting and rolling plant. The company is a joint venture between Arcelor-Mittal and Gerdau Ameristeel. It has a total staff of 450 people.

To support the coil grading process, Gallatin had been using an in-house-developed solution based on a level 2 database. Quality assurance staff had

used the program to evaluate production values and order data and decide, based on this evaluation, whether to ship, block or re-grade a coil. These decisions had been very much influenced by the skills and experience of the individual operator and, consequently, had sometimes variations based on subjective judgement.

In addition, the IT landscape at Gallatin Steel had historically grown over the years and become heterogeneous. Numerous data, which would have been highly important for the assessment of the coil quality – including data generated by a new surface inspection system – was not always accessible for the grading decision.

The target: automated grading decision for 90% of production

As part of a major quality assurance initiative, the management of Gallatin

Steel was looking for a solution that would make it possible to exploit the existing quality data – yet stored in different systems – in order to make coil grading more transparent and objective, and less time consuming. This would assure that only coils of optimal quality would be shipped.

The objective was to reduce the effort associated with coil grading and dispositioning by 50 percent. Gallatin's long-term target is to have 90 percent of all coil grading decisions to be automated by a software supported grading process.

Another relevant aspect was to make better use of highly qualified and highly experienced quality engineers, allowing them to concentrate on genuine quality assurance tasks, namely improving quality consistently and reliably and taking care of those cases which still need human eyes and interaction for an improved judgement.

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The project: all data into one system

Two stages in the production flow were considered most appropriate as coil dispositioning points: the discharge area of the continuous caster and the exit of the hot strip mill. Behind the caster, the decision has to be taken as to what to do with the heat. Behind the hot strip mill, it has to be decided what will be done with the coil. In their search for a solution, Gallatin turned to QuinLogic because the quality execution system (QES) offered by the German company exactly fit the requirements, namely bringing together all relevant existing data and making quality grading fully transparent. Also user friendliness was a convincing factor in favor of this system as it allows even complex information to be input and modified with ease.

Gallatin placed the order in 2012. QuinLogic supplied a QES quality execution system incorporating the components LogicDesigner, Quality-Monitor and WebReporting. No special adjustments were required because QES had been specifically designed for use in the metals industry from the layout with numerous default settings relevant for casting and rolling processes already in place.

QES captures data along the entire production chain, from melting all the way through to the shipment of the finished coil. It took QuinLogic only six weeks from receiving the order to installing the software and establishing all links to the various data bases. In January 2013, Gallatin Steel integrated an additional, new Cognex surface inspection system at the hot rolling mill as a replacement of an old inspection system. Connecting the data of the new system to QuinLogic was set up in less than a week.

The basic element of the QES software is the "Metals Object Model" (MOM), which, for each individual strip, merges all data from sources as diverse as ERP, process control and material tracking systems as well as from various databases. In doing so, it merges all quality data for product width, thickness, flatness, profile, temperature, surface quality, etc. and relates them to the respective positions along the length of the product. For the first time, this offers the possibility of synchronizing and using data

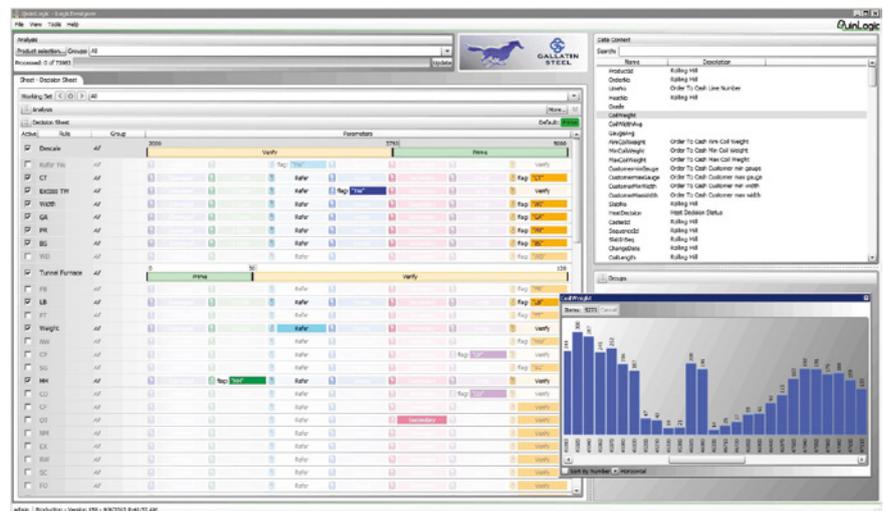
from different origins and of different formats, which is a basic requirement for any kind of useful calculations and correlations.

Gallatin uses three of QuinLogic's software modules: the LogicDesigner, developed for the quality engineer to quickly and conveniently define, add and modify rules, and the QualityMonitor, which applies the rules to the current coil in the line, calculates a quality grade and submits this calculation as a proposal to the production staff. The WebReporting module makes quality information and evaluations available across the entire organization – broken down according to criteria such as steel grades, production plants or position of a defect on the strip.

ber of slivers occur, every coil for which the surface inspection system reports slivers above a certain number is automatically downgraded without further visual inspection. The QES thus avoids unnecessary effort for sending the coil to the inspection line.

It is also possible to combine several rules. A set of rules could read as follows: "If there are more than two heavy scratches on a coil and 0.2 percent of the surface area features light scratches, or if there is no heavy scratch on a coil but more than 100 square meters feature light scratches, the coil must not be shipped to a certain customer who would use the strip for an alternative application or order."

Gallatin's customers have – like any steel producer's customers – different



For simulations with the LogicDesigner Hot Mill, the rule thresholds can be shifted by virtual sliders

Defining rules in a simple way

QES is based on rules according to which the software develops its coil grading decisions such as "prime", "secondary", "downgrade", "scrap", "verify", or "damaged". QuinLogic developed a simple, user-friendly tool for entering and updating the rules – the **LogicDesigner**. An example is "block all strips with edge cracks of more than ## depth". To define limits between the operator sets the thresholds for the individual criteria via virtual sliders on the screen. For example, for defining the distances at the strip head and tail ends over which surface defects are to be neglected, he would simply have to shift the virtual sliders accordingly.

Another example of a rule applied at Gallatin Steel is downgrading of coils at the start of a sequence: On the first bar, where typically an increased num-

wants and needs; trying to memorize all that by one person is impossible. Therefore QES allows the grading criteria to be refined as desired and adapted to Gallatin's individual end-customer specifications. The quality engineers can create rules based on individual customer specifications that are automatically executed and do not have to be recalled from somebody's memory.

LogicDesigner automatically generates the hierarchical steps according to which the rules are to be activated. The selected criteria for the rules and the respective threshold vary from application and use case but also from customer to customer.

To guarantee that the rules properly reflect the decisions taken at the line, Gallatin uses the simulation function. It provides the possibility of testing the new rules on historical data before re-

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leasing them to the actual production process. The results of this simulation are graphically displayed as red and green bars. Hence, it is possible to see at a glance whether the new rules correspond to previous coil grading results. This is particularly important in the case of fuzzy data, as for example provided by surface inspection systems. Through the simulations, Gallatin has also gained comprehensive knowledge as to how the changing of different kinds of thresholds would affect the yield.

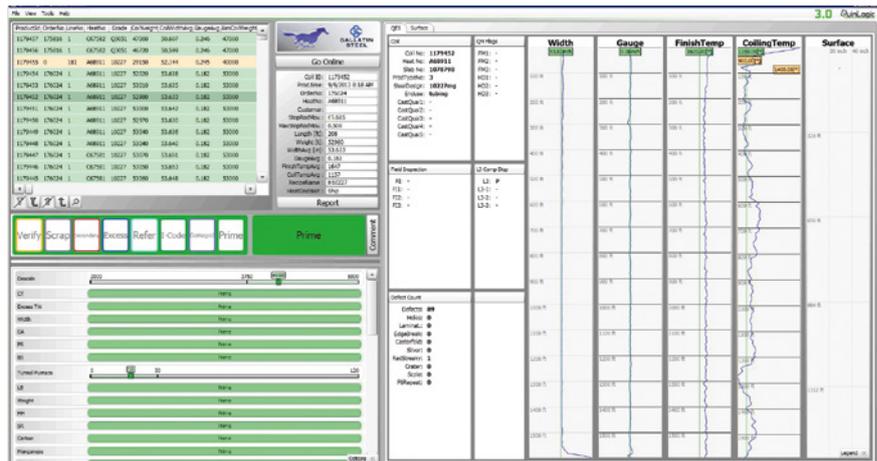
Automatic coil grading

QualityMonitor evaluates the information acquired from the production process and, if applicable, triggers the automatic blocking of coils and decisions as to what to do with the coils. The software documents the results for each coil and each process step. Gallatin can retrieve and view data of every coil complete with all its stored values. The data is presented in the form of scales, which also show the quality decisions as “prime”, “secondary”, “downgrade”, “scrap”, “verify”, or “damaged”, allowing easy assessment of the value relative to the preset thresholds. QES produces a certificate for each coil, summarizing the key quality data.

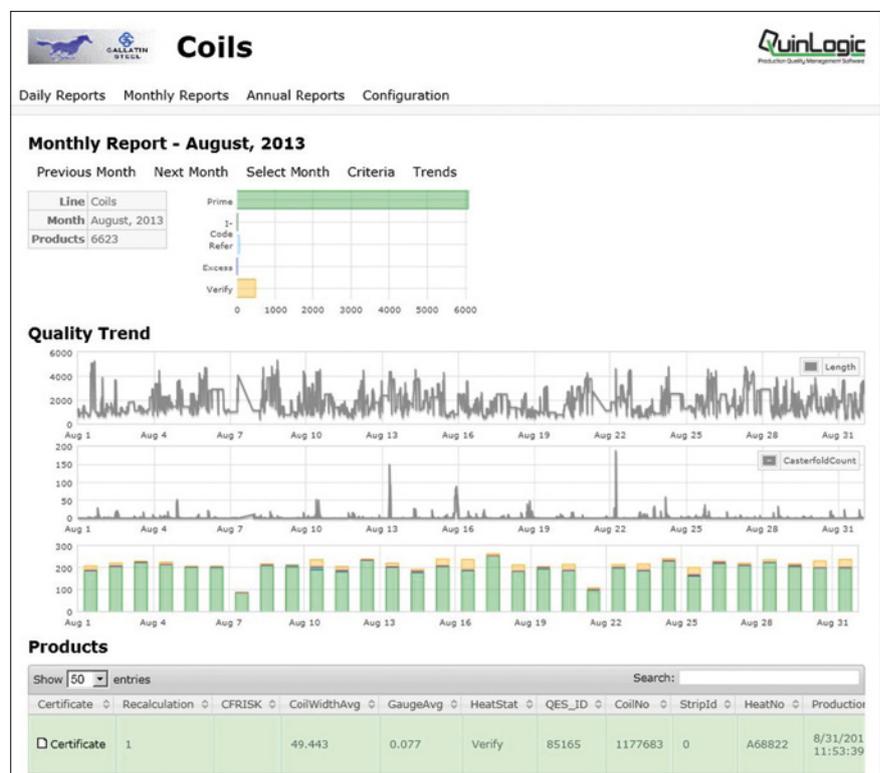
The **WebReporting** tool also provides employees not working directly with QES access to the data via the intra or internet. This is extremely useful for the management and the sales department. Through this feature, they are not only able to view the data of each coil within a context and associated with the coil length but also have the possibility of retrieving statistical data. Currently, 25 people have access to the WebReporting tool.

First operational experience

At Gallatin, two employees from the Process Technology department with previous coil grading experience are in charge of defining and updating the rules. They specify the strip quality in close collaboration with the responsible customer field representatives. The first rules were defined by entering the customer specifications for the basic parameters such as “thickness” and “thickness tolerances”. As the next



QualityMonitor screen shot



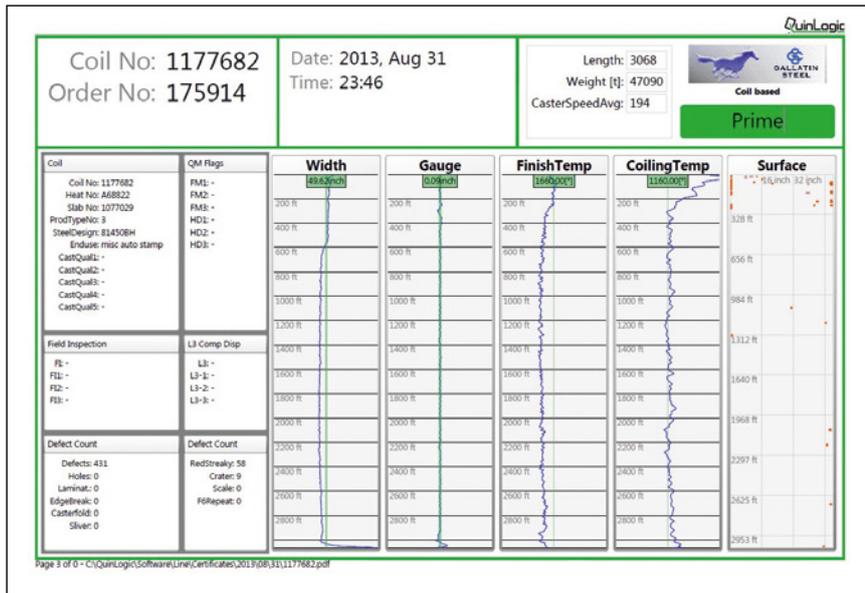
With WebReporting all data of all coils are available at any time

step, the existing in-plant rules were entered. The first round of rule setting was completed after 14 days.

It took the system only three months to operate so reliably that none of the coils classified as “prime” had to be reviewed. This applies to fifty percent of the coils. Consequently, the quality assurance staff has already been relieved from one major task because in the past every coil had to be checked by a human inspector. However, not only the working hours matter but also the elimination of monotonous activities. Currently, the rules are being further sophisticated with the objective of having an increasing number of the coils

still being checked by humans graded by the automatic system.

The users accepted the system extremely well from the very beginning. This is owed to the fact that customer-specific rules can be entered and updated in a very user-friendly manner, requiring no programming skills. A further benefit resulting from this is the independence from IT specialists. Ever since all data links were in place, the system has been working under the sole responsibility of the quality staff; a welcomed side effect of this being the fact that modifications can be made in just a few minutes without having to involve the IT department.



Every coil receives an individually configurable certificate

knowledge and experience of numerous employees and makes this knowledge available for objective use. QES is currently releasing 75% of all rolled coils automatically which require no further follow-up. Any further manual inspection of these coils has meanwhile been dispensed. Since the installation of the system, it has not only improved the quality assurance process but also a lot of small improvement steps of the production processes were triggered by data generated from the QES. A growing order inflow of Gallatin Steel shows that quality improvements have been positively recognized by the market.

The next planned objective is to automate the coil grading process up to the point where the quality assurance staff will have to visually check or further verify only 10 to 20% of the coils. Additionally, it is planned to send the results of the grading process live to the operators' control pulpits as a quality feedback.

The quality assurance team also evaluates proposals issued by the Quality-Monitor. Hence, the ultimate decision in case of borderline coils continues to be taken by humans.

An example of how customer specifications are taken account of in production concerns the requirement of recoiling coils that have been imperfectly wound. One of Gallatin's customers uses cones on the lifting fixtures of his cranes. Coils telescoping more than a certain length pose a safety hazard during the transfer by crane.

For this customer, a rule has been defined in the LogicDesigner reading that coils telescoping more than specified have to be recoiled. In general QES is significantly increasing the robustness of the process, and thus supporting the quality driven tactic to get more market share and service to the customers and to ship what they require.

Conclusion

QES is a rule-based coil grading system, which combines many years of