MANAGING THE QUALITY OF FLAT STEEL PRODUCTS ALONG THE PRODUCTION CHAIN[1]

Helga Evers [2]
Hans Peintinger[3]

Abstract
Managing the steel quality is a challenge: many sequential process steps are involved, a rising variety of process routes, an escalating number of product grades and always tighter customer specifications. The challenge is further increasing by a rising number of new and improved gauging systems. Those systems deliver more quality and process data at higher resolutions to achieve improved accuracy. The optimum exploitation of the gauging system investment and the best use of this data is the key objective of QuinLogic's Quality Execution System (QES). The QES software suite handles high resolution measurement data along the process chain to improve the utilization of all kind of valuable resources. The target is to automate the decision whether to release, process, block, repair or re-route a coil. A most accurate decision is important because of its direct impact on further value adding, order fulfillment in time and internal logistics.With the QES – Quality Execution System steel makers can now get more benefits from their already installed gauges. All prerequisites are fulfilled to employ data efficiently for quality decisions and process optimizations. Conclusions derived from data are now much more transparent and reproducible. The QES ensures delivery of reliable and homogeneous quality – a key factor to differentiate in competitive markets.
Key words: Quality grading; Quality assurance; QES-Quality Execution System.

[1] *Technical contribution to the 50th Rolling Seminar – Processes, Rolled and Coated Products, November, 18th to 21st, 2013, Ouro Preto, MG, Brazil.*

[2] *QuinLogic GmbH. Aachen, Germany. Helga.Evers@quinlogic.de*

[3] *QuinLogic GmbH. Aachen, Germany. Hans.Peintinger@quinlogic.de.*

1 INTRODUCTION

This paper describes a method how to ensure compliance with the specified quality. Quality assurance is continuously gaining importance in the flat steel production. With the increasing number of high performance gauging systems the potential for the use of those gauge results exploded.
QuinLogic' objective is to develop tools to exploit gauge investments to better qualify the steel quality and derive the decision to ship, block, re-route or repair the coil. With a new software technology all kind of high resolution gauge data can now be synchronized and used for computer assisted qualification rules as well as for data analysis purposes.

2 MAIN TEXT

The key features of a Quality Execution System (QES) are to track quality including decision support per individual coil produced, exchange sequence related information with the MES and ERP systems and feed process related information back into the set-up for the next coil.

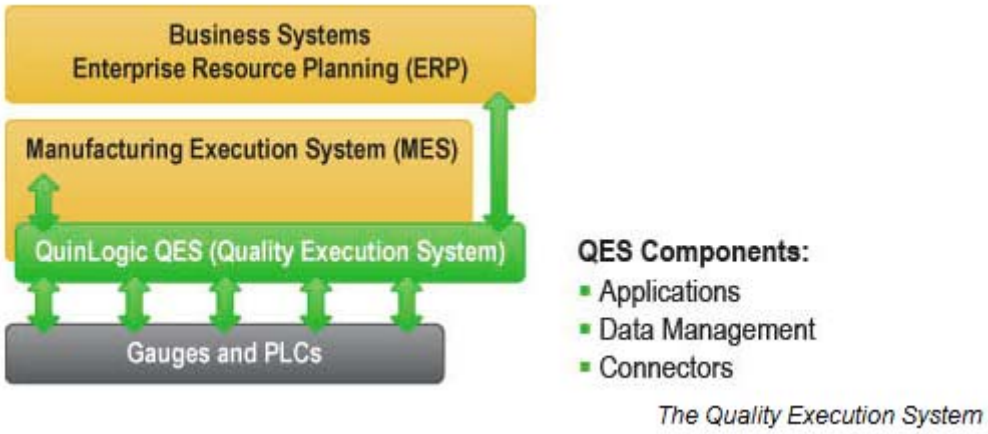

Figure 1. The QES in the Data Hierarchy.

From all these activities, decision support is obviously the most important and critical activity, given the amount of investments into advanced monitoring and gauging over the recent years.
In case of deviations especially high end (e.g. automotive) customers require more detailed information on tolerances and production data.
As a basis for a long, investment protecting roadmap, QuinLogic has created a Metal Object Model (MOM) as a foundation and backbone for all QES related applications. The MOM supports a variety of native data formats of all kind of different gauge vendors. It also features a customizable generic access. This data fusion is the key to implement any sort of calculations for quality or process optimization.

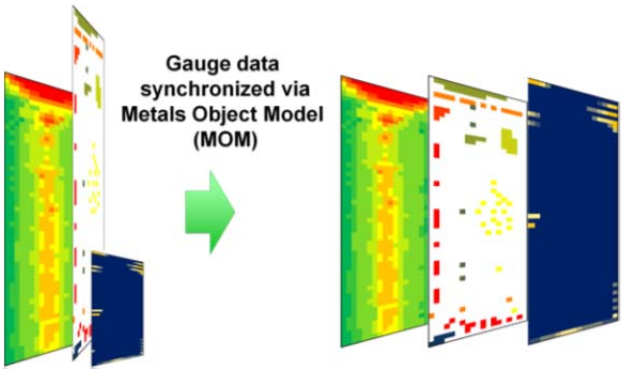

Figure 2: MOM - Gauge Data Synchronized with the Coil.

To create the prerequisites for the quality decisions, a number of steps need to be taken:

- Data from various data bases and as much raw data as possible must be processed;
- Data needs to be synchronized. A lot of data is time stamped (in various resolutions from milli-seconds to minutes depending on how it is needed to guide the process. Decisions on products are not time but position based and to decide, all data needs to be adjusted to match positions.
- Decisions are first (a) individual per type of data und then (b) combining several quality characteristics. This is essential because a piece of metal may still be good on temperature and reasonable on surface but in conjunction, it's a block.

The practical use of the MOM is realized in different applications within the Quality Execution System. Two major modules are

- LogicDesigner, enabling the quality engineer to easily create, verify and modify quality rules;
- QualityMonitor, applying the defined quality rules for any individual coil during and proposing a grading result in real-time.

The LogicDesigner is used to describe rule based decision conditions.
The quality criteria imposed through the steel order is converted into a quality rules set using the LogicDesigner. These rules are then executed per coil (or tube or lot or…) and a grading result displayed to quality experts for approval.
Data is provided from databases and gauges directly into the QES. An internal component aligns the data needed for a quality decision.
Based on the data, quality engineers and customer support defines the quality criteria per steel grade, per customer, per application case or even per order, using the LogicDesigner. The decision service uses this rule definition and matches the information obtained for a particular coil with the quality definition as stated in the rules. The result is saved into the results database. The QualityMonitor is used to display and review results and to argument the decisions calculated.
The QES is a software system for grading coils with 5 major components:

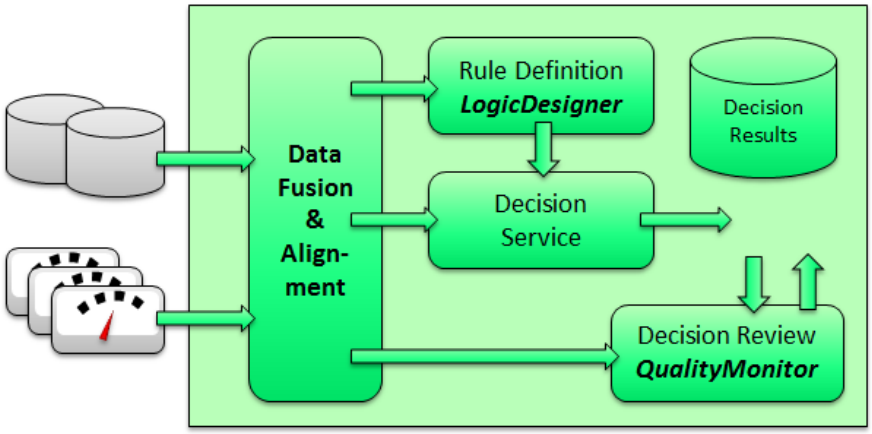

Figure 3: The quality execution system components.

The decision support requires an underlying quality approval scheme. This scheme may be highly individual: per process step, per steel grade, per customer, even per order or for a particular production day. To determine a quality approval or reject, typically a lot of “rules” apply – origination from the order specification, from verbal communication with the customer, and of course requirements from the production process itself.

This ensures that the responsible managers are in control of the application of these rules and also in control of potential exceptions. Quality managers together with customer support personnel at the end are in charge of managing the quality profile.

The key to translate customer requirements and specifications is a number of specific quality rules. Rules may have various variants e.g. a rule for automotive exposed material may have tighter limits compared to the same rule for non-exposed products. Quality compliance is defined as compliance with every individual rule. If one fails, the product fails. All rules applicable for a particular product combined is called a rule set.

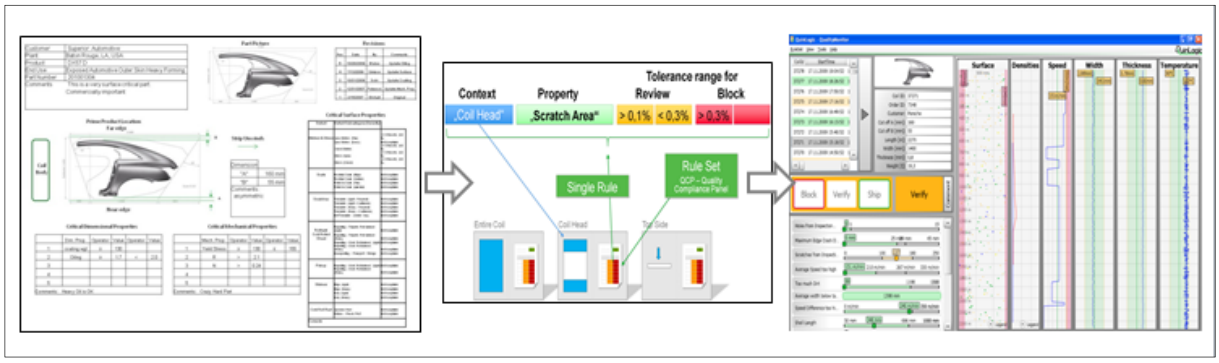

Figure 4: Order specification translated into rules.

Steel mill’s target is to produce higher quality with highest efficiency. Therefore all quality critical decision points in the process flow are foreseen to be equipped with a QualityMonitor.

The QES supports the collection of process know-how and reveals areas for improvement. The improvement process starts immediately after installation and is ongoing over following years of using this software tools.

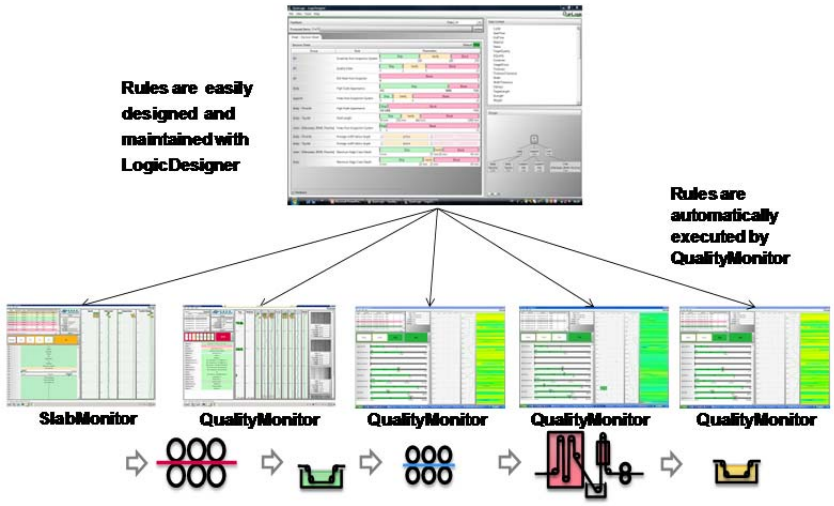

Figure 5: Quality assurance along the production chain.

A QualityMonitor at each production step ensures that decisions concerning ‘on hold’, ‘repair’ or ‘re-routing’ are taken as early as possible to prevent adding cost to non adequate material. To achieve this, a data connection has to be set up to the relevant databases (MES, ERP and databases of measurement devices like mold level, tundish, flatness, roughness).

2.1 QualityMonitor Features

Each single coil will be evaluated based on a harmonized (corporate), transparent and comprehensive rule set.
All premium coils receive a certificate which is stored for years.
All secondary coils receive a detailed report listing reasons for downgrading and comments of the decision makers, stored for years.

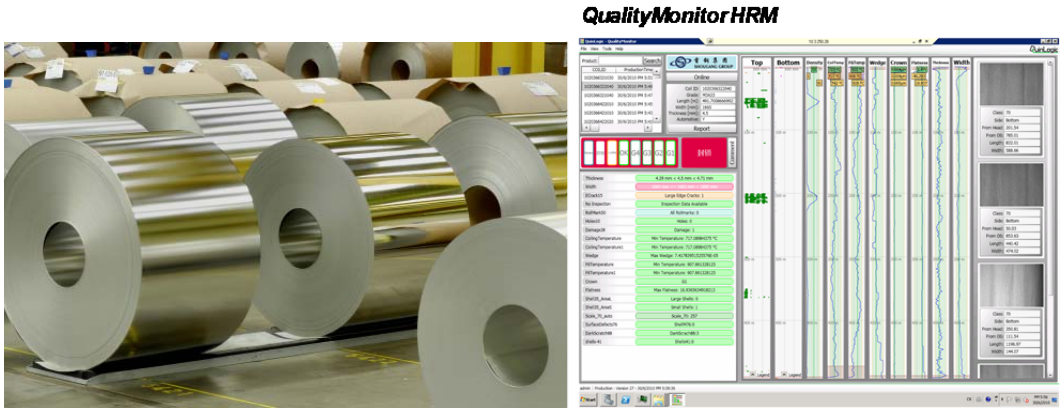

Figure 6: Detailed grading result per coil displayed on the QualityMonitor.

A customized Quality Certificate as report (pdf) will be provided and stored for each coil. It allows you to retrieves both detailed results and measurement graphs even after several years, even if the data is no longer in the database. This allows the fast and easy identification of the quality status for all delivered coils in the case of customer claims.

Coil Certificate

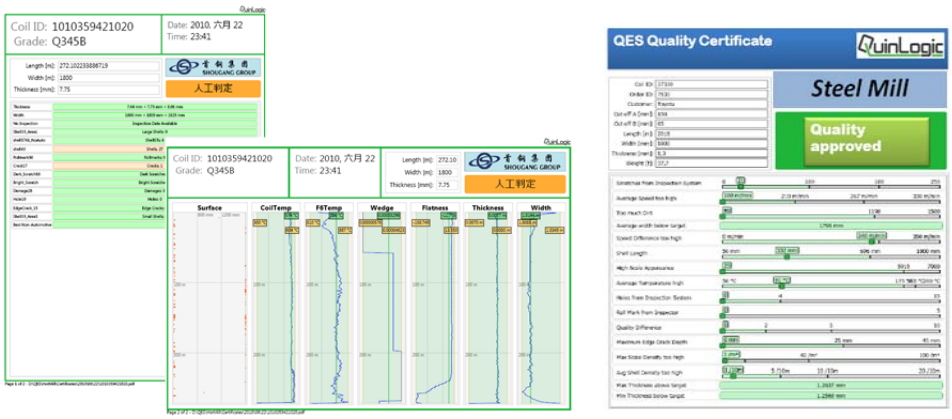

Figure 7: Coil certificate with detailed grading results.

3 SUMMARY AND OUTLOOK

With the QES – Quality Execution System steel makers can now get all the benefits from their already installed gauges. All prerequisites are fulfilled to employ data efficiently for quality decisions and process optimizations. Conclusions derived from data are now much more transparent and reproducible and available online in a few seconds.

Significant future steps are the support of fuzzy quality decisions as well as automatically derived rules.