

# AUTOMATIC ONLINE COIL GRADING – AN INNOVATIVE SOFTWARE APPROACH<sup>1</sup>

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## **Abstracts**

An advanced software implemented method to support an inspector's decision about a coil after each processing step to determine the coils future, ship or block, process, repair or re-route. For the first time, the full spectrum of gauge data from surface inspection to online roughness can be exploited to generate intelligent quality decisions. This paper presents a software approach, pioneered in 2005 in three installations to model grading decisions with rules from databases, to incorporate data from all available gauges with results on a single operator screen. The inspector does no longer take care for the obvious decisions, because the machine grading takes that part and at the same time provides to-the-point information for the non-obvious decision process. The unique aspects of this approach are the advanced data integration methods and software decision capabilities based on the *parsytec 5i* technology. For the first time, not only rejects, but also re-route and re-assignment decisions are possible through the integration of customer quality specification data and the access of order databases online. As a result, reduced internal rejects and a significantly improved re-assignment rate of non-prime coils to other orders have been observed.

**Key words:** Surface inspection; Surface quality yield management; Application production; Optimization.

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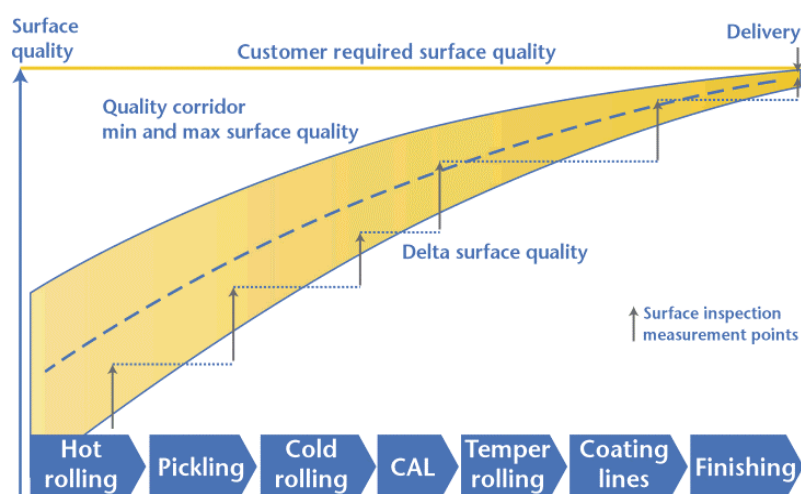
## 1 *parsytec 5i* - DECISION SUPPORT APPLICATIONS

Surface inspection is not just all about obtaining data; it more importantly encompasses processing inspection data and thus turning them into quality data.

Inspectors need support in their daily decisions on the handling of coils: rejecting or accepting them for delivery, assigning coils of a certain quality to orders, re-routing or repairing coils. *parsytec 5i – the Surface Excel* offers the possibility to create customer-specific application sheets with all the data and calculations need for these decision processes.

The need for individual application building can be explained with the market development. Today's steel market can be characterized as a seller's market: industry analysts report a continuously increasing worldwide metal demand as well as global inventories to be far below the average. This lets them expect no downturn in the apparent consumption cycle in the near future, while, at the same time, they also notice only a flat growth of the global supply. In such a market environment, usually capacity dominates quality, because nearly only completely produced steel can be sold.

However, capacity and quality can and ideally should be combined: when thinking of quality, the focus often lies on the question how intermediate products match final customer specifications throughout several production steps. In this process, quality characteristics are transformed following precise process instructions of its order specific routing. The quality corridor – i.e. the bandwidth of the tolerable quality according to customer specification – becomes tighter from production step to production step: With production moving downstream, the commercial value of the intermediate material grows, and the degree of freedom for re-routing decreases. Yet at the same time, upstream opportunity costs due to delayed identification of missed quality characteristics increase. Consequently, if current surface quality does not meet the target characteristics in any stage of the value chain, decision processes must be triggered. Such decisions are mainly based on quality data, among which surface quality data play a central role due to surface quality representing a key value driver in steel production.



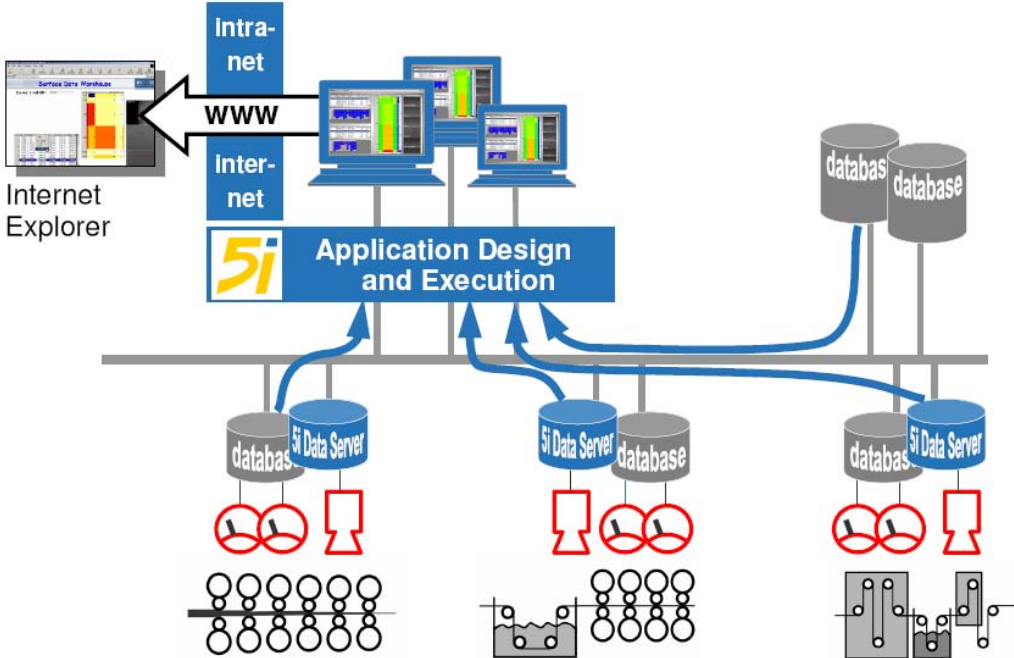
**Figure 1.** Optimizing capacity and yield means taking decisions as early as possible

When it comes to capacity optimization considerations, more than local surface inspection systems are needed: The customer-specific quality corridor must get

enriched by a capacity-centered quality view. As the value per produced ton increases while processing the intermediate coils through the production chain, downstream bottlenecks have a high leverage on the yield. Controlling quality in the upstream processes with respect to the requirements of the subsequent process steps can enable steel producers to release downstream capacity bottlenecks. This in turn requires a cross-line view of the quality corridor. One example may illustrate this: A Parsytec surface inspection system at the hot rolling mill reliably indicates the scale pit density. Assessing these quality data through the customer-oriented quality view may lead to the conclusion, that the produced material is not harmful with respect to customer requirements. Consequently, no action is triggered. However, looking at the same data with respect to the capacity of the subsequent pickling line may reveal the information, that the respective coil can get processed with a higher pickling speed. This in turn would immediately lead to better capacity utilization and increased output – while simultaneously securing high delivery quality through the customer-oriented quality view.

**2 THE INNOVATION: SURFACE EXCEL**

During every day’s operations, many similar decision situations occur like grading and processing of surface quality data to support processes like adaptive routing, re-allocation, re-routing, correlation, or process optimization. For the majority of these situations, surface inspection systems at all production steps reliably generate core data to trigger the required decisions. But the general output of a surface inspection system are raw inspection, and not the customer-quality and capacity-oriented views outlined above. This leads to a situation, where the often mission-critical surface quality data seem to be there, but virtually are locked inside the surface inspection systems.



**Figure 2.** parsytec 5i - Infrastructure

Hence, the situation is the following: a surface inspection system gains huge amounts of “raw” data. These data include surface inspection data, measurement

data, process data, order and material data. *parsytec 5i* unlocks those by turning them into valuable and usable data.

In order to improve surface quality decision making, Parsytec invented a new dimension of surface quality yield management: *parsytec 5i* – the Surface Excel. *parsytec 5i* claims not to be an “out-of-the-box-solution” for all quality and capacity-related decision processes. Obviously, these decisions have a strong impact on the competitive edge of the steel makers and cannot get served with a one-size-fits-it-all approach. The purpose of *parsytec 5i* is to enable many people at the steel producers to create powerful specific solutions for improved real-time surface quality decisions by themselves.

*parsytec 5i* makes the relevant information available for many people in the steel works. In Surface Excel, *parsytec 5i* looks at a coil as if it is a grid of metal sheets. And this grid is like the shadow of the coil. If a surface inspection system detects severe defects on parts of the coil, the respective cell of the grid reflects this, e.g. by changing its color. If the coil flips, the grid flips. If two coils are welded, the grids of these coils merge. And if coils are cut, the grid is cut as well. Grids are a kind of steel intelligence built into *parsytec 5i*. And they provide the look and feel of a Microsoft Excel. This makes them easy and intuitive to handle.

As a tool to enable metal makers to develop their individual decision-support solutions, *parsytec 5i* comprises of a comprehensive Application Development Studio. As this Application Development Studio follows the ease-of-use paradigm of Excel and the steel-intelligence paradigm of the grid technology, it already helped Parsytec to create a number of sample solutions for typical quality and capacity decisions. They tackle the broad range from back-tracing defect origins from hot rolling to casting in order to support slab blocking over benchmarking the productivity of several production lines to comparing the yield of whole shipments to various customers.

### **3 APPLICATIONS IN PRACTICE**

*parsytec 5i* is a software approach, pioneered in 2005 in three installations to model grading decisions with rules from databases, to incorporate data from all available gauges with results on a single operator screen. The inspector does no longer take care for the obvious decisions, because the machine grading takes that part and at the same time provides to-the-point information for the non-obvious decision process. The unique aspects of this approach are the advanced data integration methods and software decision capabilities based on the *parsytec 5i* technology. Surface Excel is now operating online and is in the position to integrate Microsoft Excel dynamically. Hence, Excel can now be used as one of the tools or components Operators can now display, calculate and aggregate data in Surface Excel, whereas the charts and statistics can also be shown in Microsoft Excel.

For the first time, not only rejects, but also re-route and re-assignment decisions are possible through the integration of customer quality specification data and the access of order databases online. As a result, reduced internal rejects and a significantly improved re-assignment rate of non-prime coils to other orders have been observed.

*parsytec 5i* counts some of the biggest metal producers of the world as its customers. Without exception, the customers are greatly satisfied with the results achieved by Surface Excel. Customer reported saving are for process analysis 250,000 - 3,000,000 US\$ per year, with respect to material allocation it is even 500,000 - 8,000,000 US\$ per year.

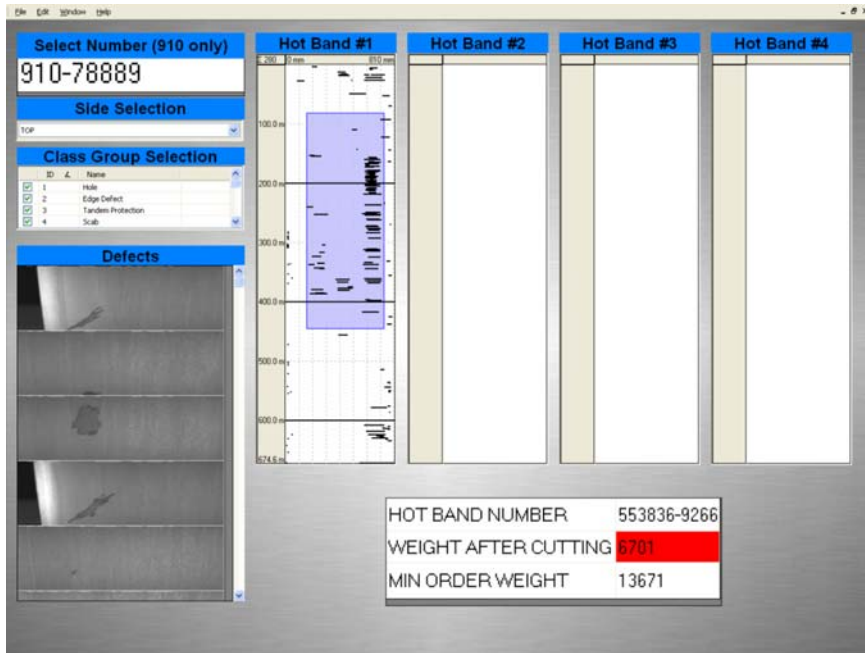


Figure 3. Coil Release – Mittal (I/N TEK), USA

The application “Coil Release” calculates the coil weight after defective areas are cut out. It compares then weight with the order data and evaluates, if the weight ranges within the defined minimum limits.

If the coil weight is below the threshold, a red alarm will be generated and thereby signals the operator a derivation from the order data.

This alarm allows time effective virtual coil cuts and avoids shipping of too low weight.

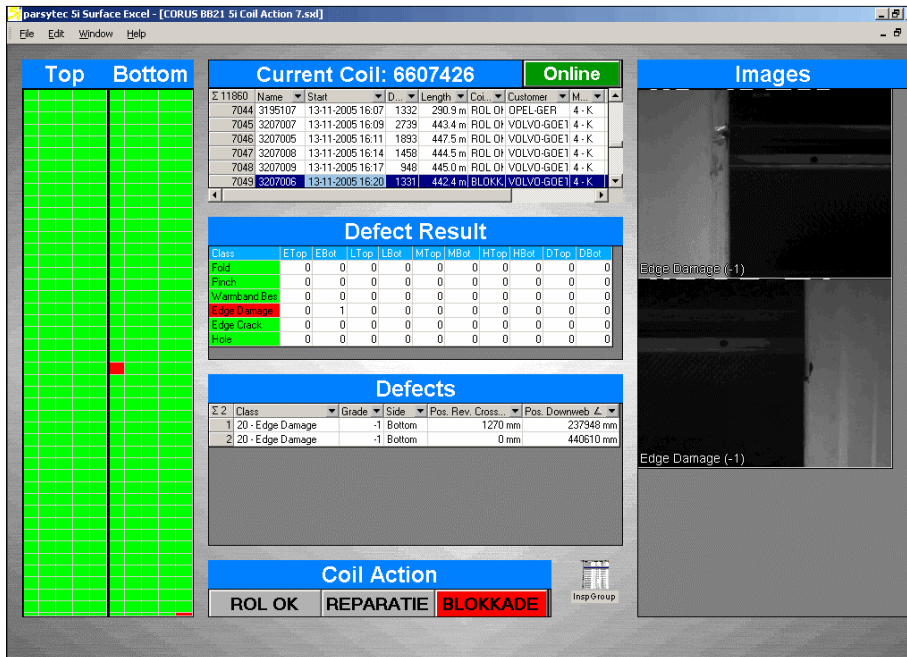


Figure 4. Coil Blocking – Corus Strip Products, NL

The Coil Blocking application lists all coils and displays the current one “online”. Pre-defined quality actions form the basis for recommended actions: If the coil quality matches quality requirements, then no action is needed. Further actions encompass blocking of the coil or repairing the coil. This application ensures objective and constant action for defined quality thresholds.

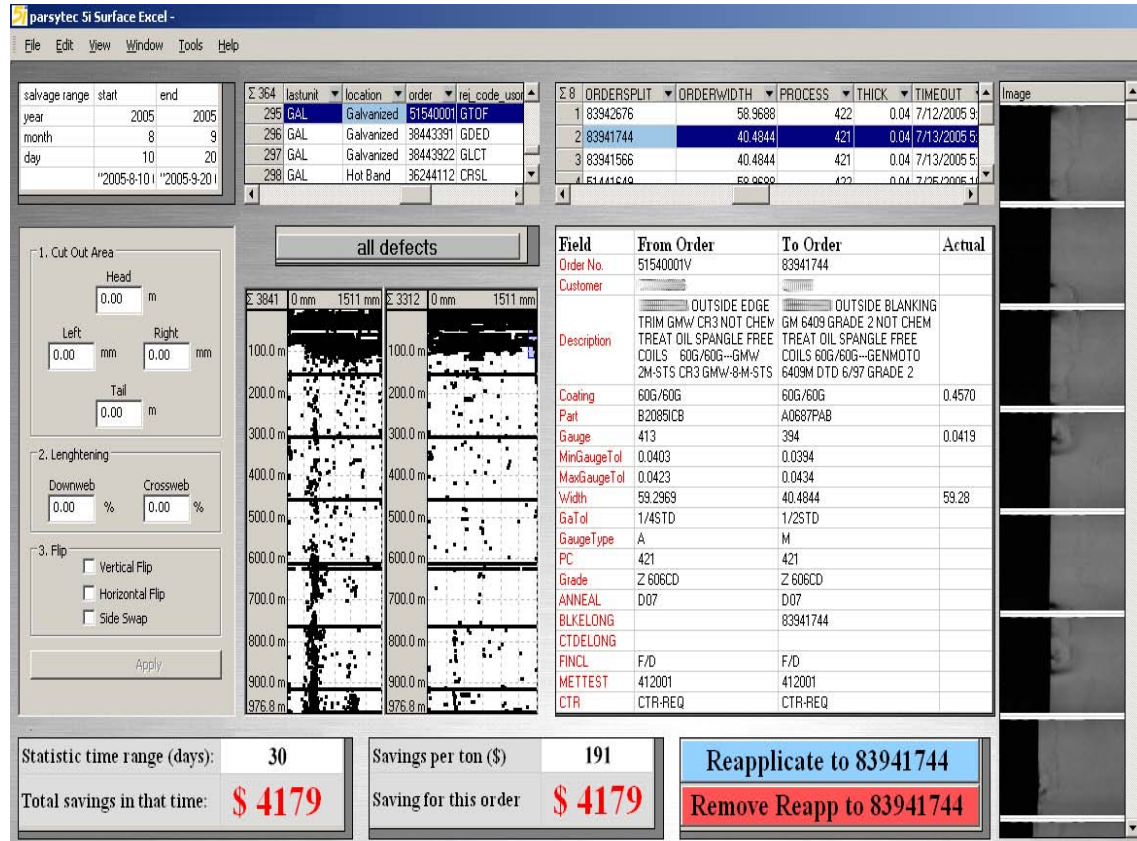


Figure 5. Re-Application of Coils – Mittal (ISG), Lackawanna, USA

During the coil production, coils of inferior quality can be rejected. Surface Excel yet enables the re-application of the coils by listing them in a spread sheet. The software automatically compares the list of rejected coils with the order database by checking quality criteria for alternative orders and suggests the re-application of certain coils to matching orders.

Besides monetary costs, this application also saves a significant amount of time to find alternative coils that can be shipped as prime quality. Moreover, Surface Excel allows here fast judgments based on all quality information including the defect images.

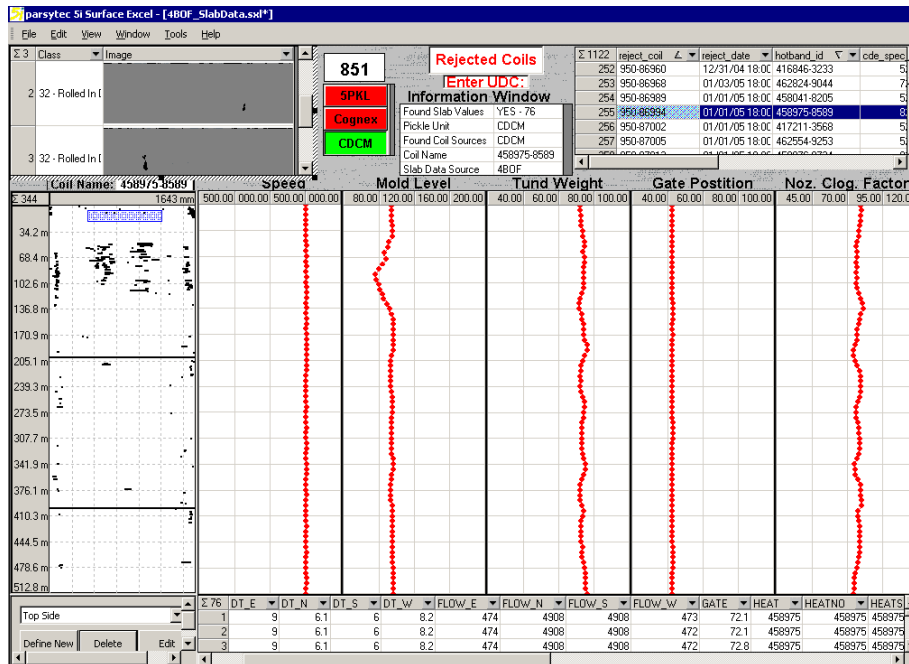


Figure 6. Process Analysis – Mittal (Ispat), Chicago, USA

The Process Analysis is crucial for the best possible economical evaluation and exhaustion of production process. Here, all coil-relevant information is displayed: defect information and measurement data taken from various databases are shown side by side.

This enables showing the correlation of surface defects with process variables.

In order to improve production processes, this application also allows an early warning by giving the possibility to early identify process problems and bottlenecks.

*parsytec 5i* now also integrated a web extension module for creating coil reports basing on HTML. Reports will then be generated in the internet containing information on the coil, the defect, the required or recommended action as well as the defect image itself. This enables also the access to Surface Excel results within the company intranet.

Surface Excel is also able to design web pages automatically. *parsytec 5i* creates the web pages and updates them continuously online with the latest changes. The usability for the operators is simplified significantly, as no HTML specialist and no web page maintenance will be needed. It is accessible from any place, where intranet and/or internet are available. The web information is password-protected against external access. *parsytec 5i* goes WEB - and makes further user-friendly functionalities possible: automatic reports, statistics, automatically sent e-mails or SMS on pre-defined events.

## 4 OUTLOOK

Today, *parsytec 5i* has gained great acceptance of the world metal producer market as it is reflected by 22 sold applications solely in 2005. Especially the North American market shows keen interest in this software solution. Sample applications can be rebuilt and customized for a great variety of customer requirements.

The majority of *parsytec 5i* applications are clustered around the Material Re-Allocation application, the Process Optimization application very customer-specific Coil Grading applications.