

SURPRISES ON SURFACE DEFECTS FROM HOT MILL TO GALVANIZING LINES¹

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Abstract

Purpose: In order to optimize coil releasing and coil re-routing, it is necessary to analyze evolution of defects and their corresponding impact on downstream production processes. The Defect Tracking software implements the matching of selectable defects or regions with observations from downstream SIS. As a result of judging the downstream impact, coil release and rerouting decision rules can be optimized. **Methodology:** Classification must be accurate and reliable regarding the severity of defect grades. It enables comparing the defect grades starting at the hot mill over all subsequent processing lines. Furthermore, the *5i* application displays, which defects disappear during the next processing steps – for example in the pickling or annealing process – by giving the exact number of defects. This additional knowledge helps to save costs for repairing processes, which might have been applied unnecessarily. Therefore, the difference in defect numbers can also depend on the analysis direction: with or against the material flow. **Result:** The application gives instant information on the defect's occurrence including a filter possibility for the severity class. When tracking the coil to the pre-process SIS data, the application shows a coil map of the current process step next to the coil map of the same coil in pre-process in the same orientation. *5i* matches selected defects by position calculation and geographical patterns and searches automatically for the best match in the selected defect subset. This software thus enables fundamental decision support based on coil defects and the setting of the accurate severity grade at each line.

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Introduction

Automatic surface inspection already provides a great variety of different information in different forms. A coil report includes inspection information as well as defect images and even videos. The shift report is configurable for a specified time period and informs about the defect history. The width report gives an overview about the produced material widths and potential deviations from given specifications.

parsytec 5i supports unlocking a huge amount of additional data retrieved from different databases to be transformed to quality information aiming at fast and reliable decisions in the process flow. *parsytec 5i* was designed as a highly flexible tool that can be used for a great variety of data- and result evaluation. Data from various sources can be integrated in order to support the operator's decisions of how to treat the coil or deal with a surface defect. These assessments include decisions about a coil after each processing step in order to determine the coil's future, ship or block, process, repair or re-route. For the first time, the full spectrum of gauge data including surface inspection can be exploited to generate intelligent quality decisions. Going further than just acquiring inspection information, *parsytec 5i* addresses quality decision applications as quality is related to more than just surface defects.

- *5i* is able to integrate all relevant data from different databases
- *5i* calculates rule based decision recommendations
- *5i* collects and synchronizes information from more than one line

Recent market trends show that metal producing companies tend to consolidate and thereby join and optimize their strengths. This in particular effects the selection of the best process route under technical and economical conditions. In order to enable customer deliveries of specialized products, matching coils to detailed mechanical, chemical and quality requirements via a variety of process routes, the product qualification data needs to be available from every line and decision making needs to be formalized to be executed everywhere – regardless the actual process route.

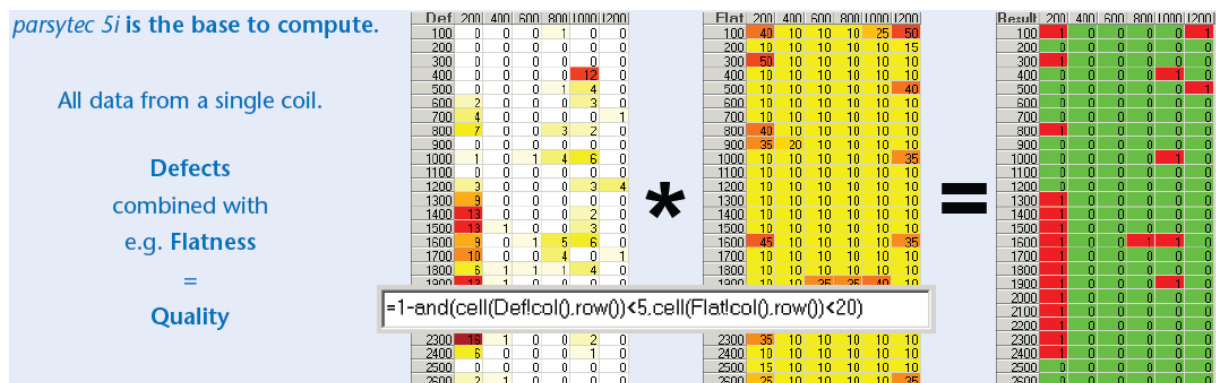


Figure 1 Quality yield management with grid-based software

All applications include features to secure target quality, cost saving and yield optimization.

In order to achieve the above mentioned customer-oriented goals, customer-specific rules and material specifications are implemented. The stored information allows unified decisions based on the same rules for each individual quality inspector.

One of the most efficient applications supports to disposition material, re routing or the Reassignment process of coils.

Accurate Classification as Basis for Quality Yield Management

The guiding principle of state-of-the-art intelligent classification technology is to make surface inspection systems work like metal producers use to work. It allows defect class naming according to the metal producers' conventions. In the daily decision making processes, defects are checked by appearance, judged by experience, and subsequently appropriate conclusions and measures are taken. SIS technology must support exactly this process in order to become accepted part in the decision loop.

Of course, the source for each kind of classification is the detection of non-perfect areas of the strip. Such appearances on the strip are then described by their characteristics. With these so-called "features", different defect classes can be distinguished by establishing appropriate classification rules. Obviously, more features imply a more precise description of a defect and thus better classification resulting in more specific and reliable results. Parsytec's classification software calculates more than 800 features for any of the selected images and additionally employs metal producers' expert knowledge for achieving the best inspection results. By this, surface inspection generates appropriate information for value chain optimizations. This will be outlined with two examples stemming from the metal manufacturing applying the Parsytec technology – and thus gaining competitive edge by being enabled to improve their operations in real-time.

Defect Tracking

In order to optimize coil releasing and coil re-routing, it is necessary to analyze evolution of defects and their corresponding impact on downstream production processes.

The Defect Tracking software implements the matching of selectable defects or regions with observations from downstream SIS. As a result of judging the downstream impact, coil release and rerouting decision rules can be optimized. The software package can compare any two (or more) lines in direct or indirect sequence. The application Defect Tracking is targeting quality engineers. After selecting a coil from a list or directly by name, the inspected data is reduced to severe defects. The application gives instant information on the defect's occurrence including a filter possibility for the severity class.

When tracking the coil to the pre-process SIS data, the application shows a coil map of the current process step next to the coil map of the same coil in pre-process in the same orientation. *5i* matches selected defects by position calculation and geographical patterns and searches automatically for the best match in the selected defect subset. Quality decisions or process information can be written back to any database. Information is available immediately after the inspection of a coil is finished.

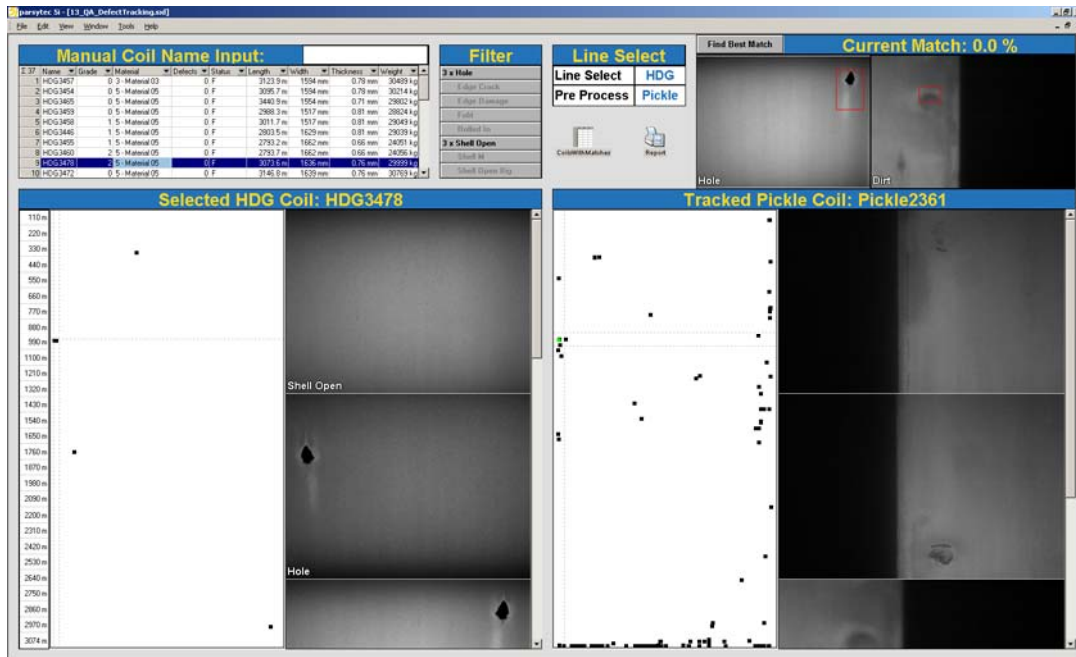


Figure 2.

Functionalities

Within the application, the coil list must be opened in order to select coil – simply with a mouse click or via a search for a specific coil name. The coil then shows the defect occurrences and distribution over the complete coil as well as the respective defect images.

Specified lines will be compared against each other as the application tracks the coil to preprocess inspection data: the operators have the opportunity to see one coil's defect map of the exact same position in two subsequent line types – in this case, the inspection results of a Hot Dip Galvanizing line is contrasted with those of a Pickling line. The application shows the defect map of the coil in the current process step (Hot Dip Galvanizing) next to the defect map of the same coil in preprocess (Pickling) in the same orientation.

The operator can drill down to only the required information by setting filters for class severity in order to blank out irrelevant defects and anomalies. The application then matches selected defects by position calculation and geographical patterns – independent from defect classes. It then shows a percentage of the match possibility to illustrate the possibility that the operator deals actually with one and the same defect. If the match percentage ranges below a specified value, the application searches automatically for the best match in the selected defect subset.

Coil Release & Coil Re-Routing

Re-assigning coils to alternative customer orders is a demanding task for quality departments. *parsytec 5i* allows re-assignments of coils matching order information with all relevant quality data. In addition, cutting or and slitting operations can be applied to the coil data in order to guarantee the highest yield when searching for a new order.

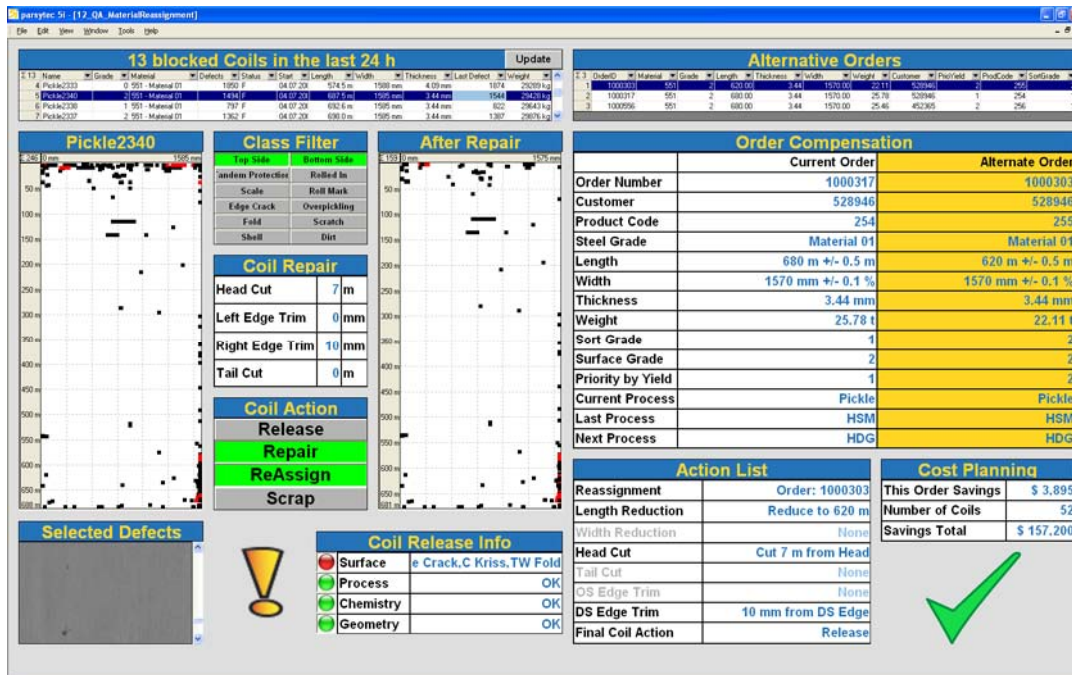


Figure 3: Material Reassignment

The *parsytec 5i* application “Material Reassignment” assists the metal producer in reassigning produced but blocked coils to alternative orders by comparing order information with surface quality data, releasing information and any production values (e.g. steel grade, thickness, width, etc.). In addition, cutting and slitting operations can be applied to the coil data in order to guarantee the highest yield when searching for a new order.

The benefits of the automated reassignment process are obvious:

1. eliminates time-consuming and error-prone process of matching hundreds of characteristics of the actual product with customer requirement
2. more comprehensive due to integrated data comparison functionalities
3. guaranteed highest yield when searching for new orders

After matching the coil against order requirements, corresponding orders are displayed in a list for manual selection based on information about specification details, trimming requirements, potential rework costs, etc. Most prominently, images of inspection systems can be reviewed directly on the screen to assess the severity of classified defects. Finally, the final decision is exported directly to the material handling system.

This application connects with various databases to retrieve all relevant data automatically. It uses custom-based rules for decisions through the application and displays all order related information enabling direct action, reporting and transmission of the reassigning action. Quality decisions or process information thus can be written back to any database. Information is available immediately after the inspection of a coil is finished. All reports are accessible via internet by adding a WWW Publishing Extension that enables instant access to all inspection and quality information at any time and any place (*this is the 21st century*).

“Material Reassignment” is customizable to specific requirements for most efficient results according to different customer processes’ requirements.

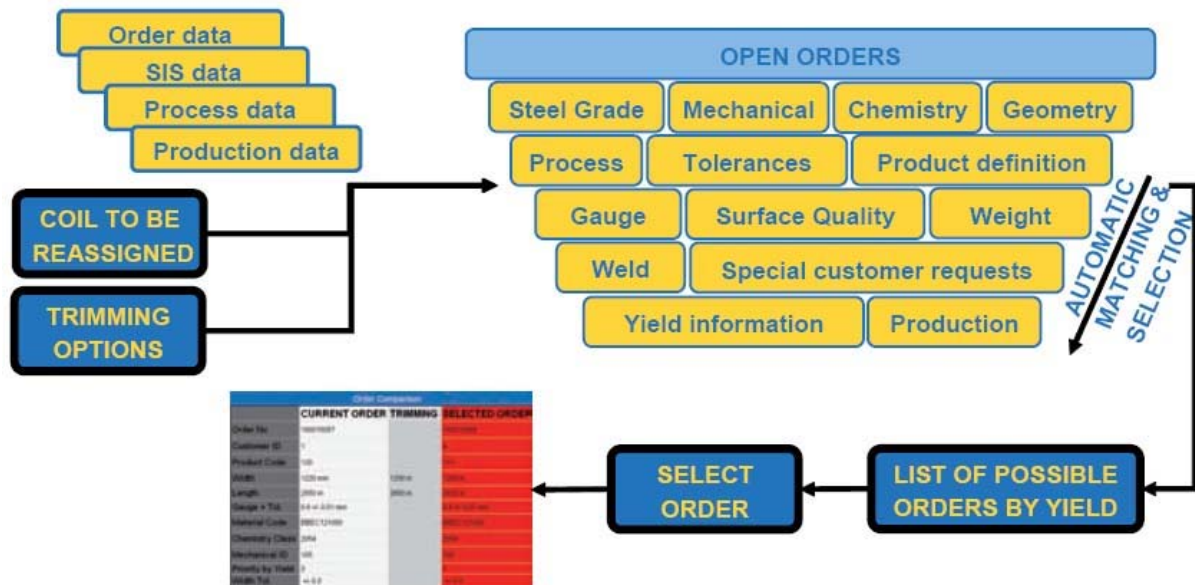


Figure 4: Concept of “Material Re-Assignment”

The benefits concern the online production as well as the resulting finished coil. By re-assigning produced coils that do not correspond to given quality requirements to matching orders, less coils will be downgraded. Consequently, fewer coils are scrapped – resulting in lower production costs and less time effort.

Due to the on-line quality monitoring, a decision can be taken to not further process coils, if the deviation from the original specification is too serious. Therefore, no more value-adding process steps – which also cost time and money – will be undertaken. If the coils are not suitable for specification, they will be re-routed immediately.

After searching investigating the order database and comparing the order data with the actual inspection results, *parsytec 5i* displays a list with all possible orders for the currently produced coil. The software thus practically makes a suggestion for the further proceedings regarding this coil and automatically supports the operator’s decision. The list of re-routing suggestions is ordered by yield priority for re-assignment and statistics about the amount of savings enables via the re-assignment of coils.

Due to the constant and verifiable quality control, a delivered material quality can be guaranteed. That way, not only costly repairs can be avoided, but also the amount of customer claims can be reduced significantly. Additionally, the data saved by the material reassignment evaluation serve auditing purposes. Material Reassignment hence avoids losing important customers or orders due to a lack of information on the actually produced material quality.

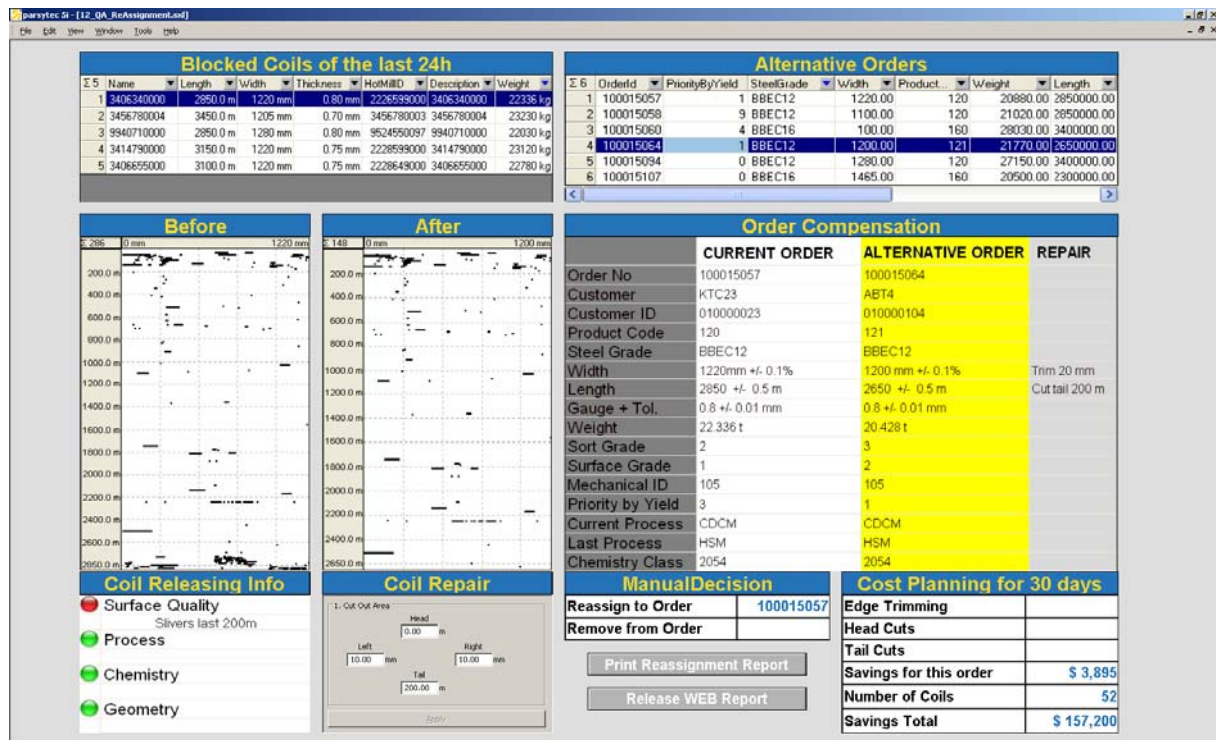


Figure 5: Material Reassignment – practical example

By connecting to any kind of database with any kinds of inspection, gauge or other third-party data, *parsytec 5i* supports on the one hand coil decisions based on the broadest spectrum of information available, and on the other it enables building mill-wide inspection infrastructures.

Proven savings by “Material Re-Assignment” total up to 1,1 Million\$/year (US stainless steel mill). This was achieved by eliminating the time-consuming and error-prone process of matching all actual product characteristics with order data. It is more comprehensive due to integrated data comparison functionalities and guarantees highest yield when searching for new orders.

A Return of Invest (ROI) below 6 months can be guaranteed as well in each carbon steel application.

“Material Re-Assignment” supports simply saving money with respect to several aspects:

- **Time:** The increased efficiency of an operator or inspector will create higher return on investment, since more work can be accomplished in a shorter period of time.
- **Yield:** Making better decisions about how to disposition material. Can it be salvaged in a more cost effective manner, or reallocated to other customers or orders.
- **Claims:** A reduction in claimed material is not only a financial benefit, but also results in higher customer satisfaction.
- **Abnormal Routing:** Sending material to repair processes that ultimately do not result in correction can be considered abnormal routing. “Material Re-Assignment” helps avoiding additional processing, if it will not improve the yield or product.

parsytec 5i in general is a highly flexible tool. By offering intuitive usability it enables the operators and inspectors to develop additional applications. General process and quality improvements will be achieved due to enhanced data analyses and reviews.

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Building a company-wide infrastructure

The larger the mill, the more inspection systems are usually integrated. In order to build a company-wide infrastructure, *parsytec 5i* enables the connection of all inspection systems via the mill network.

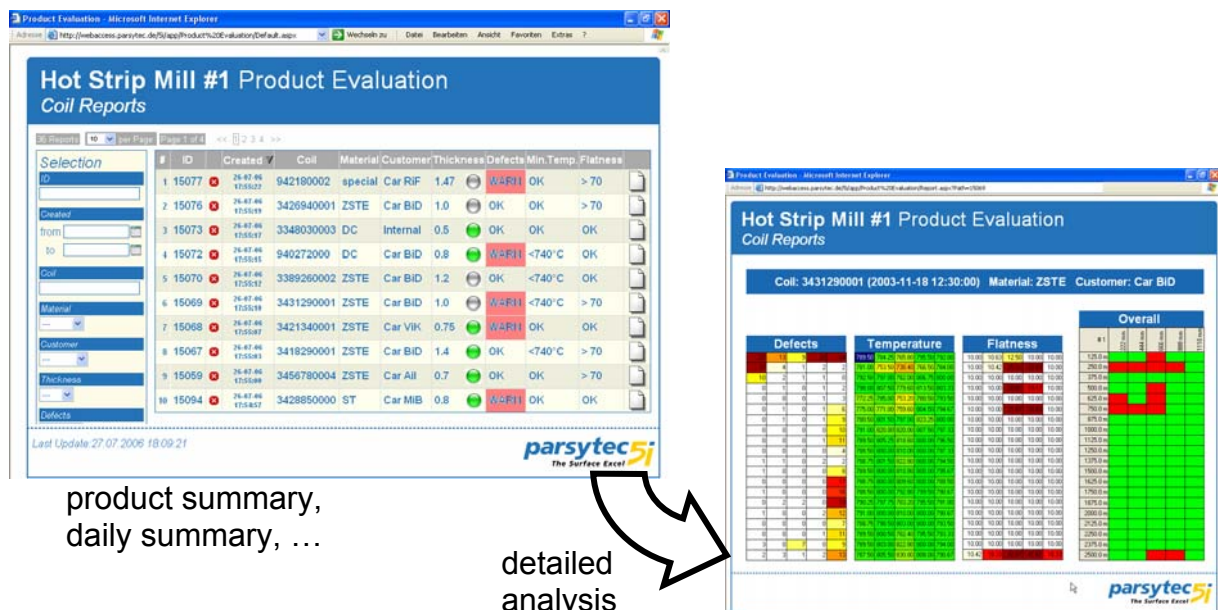


Figure 6: Supporting corporate infrastructures via WWW

In order to support worldwide operation, *parsytec 5i* goes WEB - and makes further user-friendly functionalities possible: automatic reports, statistics, automatically sent

e-mails or SMS on pre-defined events. Easy and fast delivery and access of quality information data are thus guaranteed.

parsytec 5i also integrates 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 *5i* results within the company intranet. *parsytec 5i* is able to design web pages automatically 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.

Conclusion

Quality Yield Management software such as *parsytec 5i* enables fundamental decision support based on coil defects and the setting of the accurate severity grade at each line.

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 modelling 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.