Visual Inspection Methods for Quality Control in Automotive Engineering

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Abstract

The automotive industry demands visual support for the verification of the quality of their products from the design phase to the manufacturing phase. This implies the need of tools for measurement planning, programming measuring devices, managing measurement data, and the visual exploration of the measurement results. To improve the quality control throughout the whole process chain an integration of such tools in a platform independent framework is crucial.

*We present eMMA (*enhanced Measure Management Application*), a client/server system integrating measurement planning, data management, and straightforward as well as sophisticated visual exploration tools in a single framework.*

1 Introduction

To maintain the quality of the fabrication process and of the products manufactured, workpieces are measured using a coordinate measuring machine. The respective measurement plans are based on the CAD models usually stored in Product Data Management (PDM) or Product Lifecycle Management (PLM) systems. Both systems use DBMSs (database management systems) storing other documents related with the CAD data, too.

The quality assurance throughout the process chain is composed of different, partly complex steps, which are characterized by a large set of individual software components lacking common interfaces. We have developed eMMA to integrate those different procedures and the necessary software into a single tool. Additionally, we obtain the ability to integrate new visualization methods for the generation of evaluation reports.

We have designed a modular system that can be easily extended to a wider spectrum of analysis algorithms, report styles, etc. It is already in practical use in the automotive industry, but it is not restricted to car production. It can be used in any mechanical engineering or production business.

2 System Overview

Main features of our system eMMA include the *Measurement Plans and Report Templates*, the *Online Evaluation*, and the creation and printing of *Measuring Reports*. We describe these features in the subsequent sections.

2.1 Measurement Plans and Report Templates

The whole system is centred around the MDM (*Measure Data Management*) database containing construction hierarchies along with measurement plans, measuring data, report definitions, evaluation definitions, references to the PDM system, evaluation settings, etc.

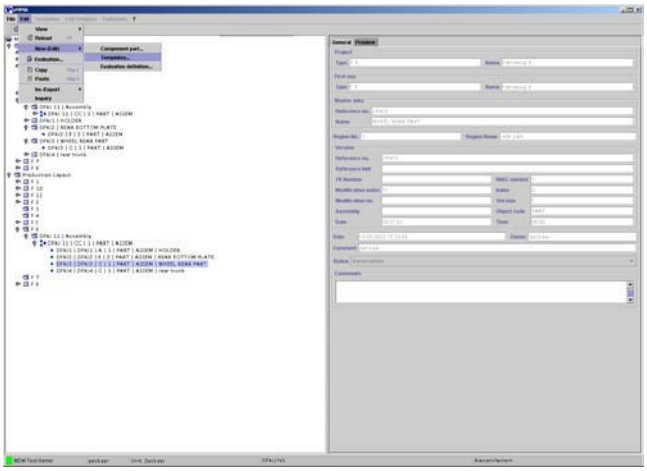

Figure 1: The eMMA main window displaying a tree of product types, component parts, and measurement plans stored in the MDM database

Figure 1 shows the MDM tree on the left side and an information panel on the right side displaying information about the currently selected node. On this tree several actions may be launched, like editing the currently selected measurement plan (structure), editing report definitions, starting an evaluation, etc. Within the component part dialog the user can edit header data, launch the measurement planning module, or edit the available quality features.

Figure 2 shows the measurement planning module with differently coloured assembly parts. This module allows the user to define new quality features, edit nominal and tolerance values, and a number of attributes. Currently, supported feature types include surface points, trim points, circle holes, rectangular holes, slotted holes, (theoretic) intersection points, and distances.

2.2 Online Evaluation

The online evaluation module comprises of several different evaluation types being applied to a single measurement plan, a prescribed set of plans, a single project, or even all active projects.

The standard online evaluation lists all quality features grouped in the currently selected report template in a table showing the features' nominal values and the deviations of the measured data. In another panel images defined in the report template are displayed with labels showing the features' locations.

Within this module additional windows can be opened showing some more feature-specific or measuring-specific evaluations. Figure 5 shows a collection of several online evaluation functions, whereas figure 3 shows a PIST (*P*oint *I*n*S*ide *T*olerance) analysis.

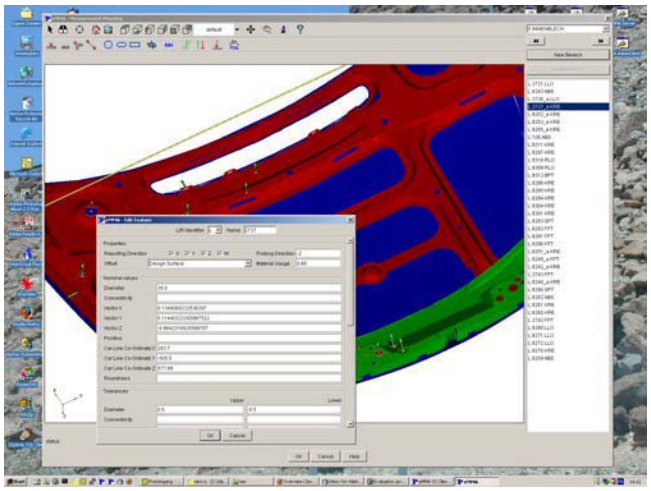

Figure 2: Editing a quality feature's nominal, tolerance, and attribute data using the measurement planning module

The upper window shows for each measuring how many features have been found to be in a red (intolerable error), amber (error is out of tolerance, but still more or less tolerable), or green (within tolerance) state. The lower window shows for each quality feature how many measurings resulted in a value within tolerance. The bar is coloured according to the percentage of measurings within the tolerance.

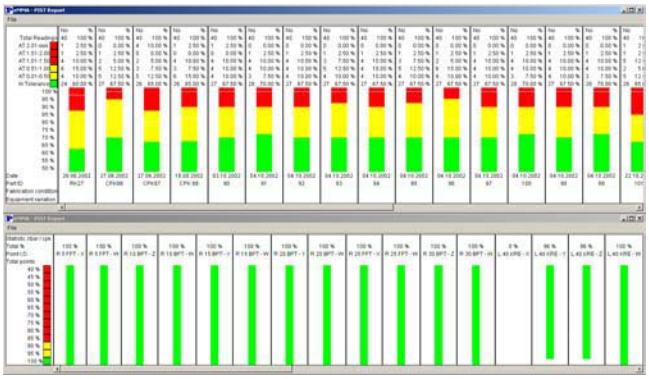

Figure 3: PIST (Point InSide Tolerance) analysis grouping either measurings or quality features

Other evaluation types that are available are the project analysis and the press line analysis. The project analysis works on a project selected within the MDM tree and evaluates CP and CPK values for all currently active component part versions within this project.

The press line analysis evaluates all currently active component part versions (cumulated over all projects) grouped by the manufacturing lines where the measurings have been undertaken. Figure 4 shows the results of such a press line and a project analysis.

2.3 Measurement Reports

Beside the different types of online evaluation within eMMA we support the automatic generation of PDF files based on customizable layout schemes.

We have implemented several modules for generating reports similar to PIST evaluation or the standard online evaluation. There

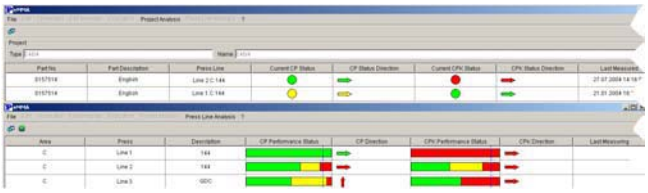

Figure 4: Results of a project and a press line analysis

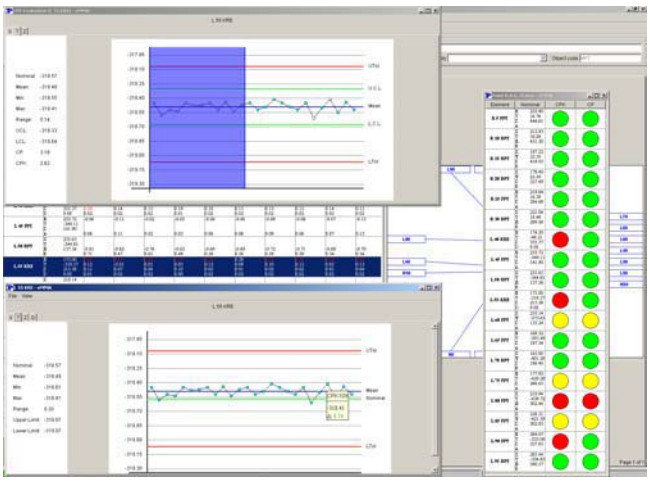

Figure 5: A collection of several online evaluation functions

are report styles showing the measured values in tables, as tabular labels pointing to the features' positions in a picture displaying the geometry, or graphically in different ways.

The system provides a process evaluation showing a part's quality throughout the whole process chain (as a single part and/or as a part of an assembly). We also offer the possibility to generate a comparison evaluation between the overall quality of different component parts that may be parts of different projects.

3 Conclusions

We presented an integrated system providing visual support meeting the needs of the manufacturing industry for quality control throughout the whole product lifecycle. We have combined tools for defining and managing measurement plans, the results from measurings, and for the visual exploration of the measuring results.

In contrast to the conventional method of using a loose collection of tools, our integrated solution eMMA is a decisive improvement in today's quality control work flow. We provide the means for a robust process chain without the risk of data inconsistencies.

Visual exploration for eMMA means not only the simple comparison between nominal and measured values of quality features from a measurement plan. The features of our system also include statistical evaluations of parts throughout the process chain, of active parts within a specified project, and of production tools used for one or multiple projects.

The users do not need to deal with different user interfaces and they do not need to switch between different applications. This leads to an improved quality control process and helps to improve the product and production quality.