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Model-based Tools for the Automotive Industry - Extended Abstract

Peter Struss[1], **Ulrich Heller**[2], **Andreas Malik**[2], **Jakob Mauss**[2], **Martin Sachenbacher**[2]

1 INDIA -A BRIEF SURVEY

INDIA (Intelligent Diagnosis for Industrial Applications, see http://lki-www.informatik.uni-hamburg.de/~india) is a project funded by the German Ministry of Education and Research (BMBF). It was launched in 1995 for a period of 4 years and aims at a substantial contribution to the industrial application of knowledge-based - in particular: model-based - diagnosis of technical devices. To this end we want to improve the possibilities to tailor a diagnostic system to the demands of a certain application (e. g. with respect to safety, environmental impact, variety, integration into development and runtime environment).

We approach these aims from two sides. On the one hand we transfer recent results of research into industrial applications. On the other hand we analyze the problems of this process and use them to drive further research. Hence, the consortium consists of research institutes, vendors of diagnostic systems and users of such systems. We are also highly interested in cooperations with industrial organizations, e. g. in establishing working groups or organizing workshops and tutorials.

To achieve our aims the INDIA consortium consists of three types of partners:

- **Companies** from different industries that represent the potential markets for diagnostic tools:
  - Robert Bosch GmbH, Stuttgart
  - Still GmbH, Hamburg
  - THEN Maschinen- und Apparatebau GmbH, Schwäbisch-Hall
- **Vendors of diagnostic tools** employing different technologies:
  - OCC'M Software GmbH (as a subcontractor of Robert Bosch GmbH)
  - MAZ Mikroelektronik Anwendungszentrum Hamburg GmbH
  - R.O.S.E. Informatik GmbH (RIG), Heidenheim a. d. Brenz
- **Research institutes** with long time experience in knowledge based diagnosis:
  - Technische Universität München
  - Artificial Intelligence Lab (LKI), University of Hamburg
  - Fraunhofer-Institut für Informations- und Datenverarbeitung (IITB), Karlsruhe

Almost all of the partners have proved their competence or interest in knowledge based diagnosis during previous projects, both with and without public funding.

To achieve highly generalizable results we look at three different application areas:

- **Mechatronic components for the automotive industry**: In the context of INDIA we are particularly interested in post-mortem-diagnosis in a service station, in reasoning with qualitative models to support FMEA (Failure Modes and Effects Analysis) and to exploit the results of FMEA in modeling for diagnosis.
- **Transport vehicles like fork lifters**: In this domain we are concerned with on-site diagnosis (post-mortem) and repair focusing on the complex electric and electronic components of such devices.
- **Installations for the distribution of colors and chemicals in dye houses**: Here we focus on post-mortem-diagnosis by operators or the service staff, on monitoring and on-line diagnosis and on predictive maintenance.

These different fields present very different technical devices including mechanical, electrical, electronic, hydraulic components as well as PLC-software. With FMEA, predictive maintenance, on-line-diagnosis post-mortem-diagnosis and repair on-site or at a service station we cover almost all of the different application contexts. For these tasks we use techniques based on fault-trees as well as on models, thus providing the possibility to compare the relative strengths an weaknesses of both approaches and to combine both techniques in developing effective industrial applications.

2 MODEL-BASED TOOLS FOR THE AUTOMOTIVE INDUSTRY

Within INDIA, Bosch, OCC'M, and the Technical University of Munich (TUM) are jointly developing three different tools:

- **Diagnostic Authoring Tool GENESIS** (Generation of Electronic Service Information): Automatic derivation of test-plans. Support of future exchange formats for service documents (J2008).
- **FMEA-Generator**: Model-based generation of failure-mode and effects analysis: Automatic derivation of the effect of component failures to the automotive system.
- **Off-Board Diagnosis**: Guided diagnosis of automotive systems in the garage. Automatic generation of test- and repair-instructions.

These tool are not only useful in themselves. They also demonstrate the integrative power of model-based technology: All tools use the same set of generic behavior models of automotive system components to solve and support rather different tasks. They establish a tool chain that supports different work processes in a product's life-cycle based on the same product model. Hence, the expected benefit is two-fold:

[1] OCC'M Software GmbH, Gleissentalstr. 22, D-82041 Deisenhofen, Germany, struss@in.tum.de

[2] Technische Universität München, Orleansstr. 34, D-81667 München, Germany, {heller, malik, mauss, sachenba}@in.tum.de

- Each tool improves the labor efficiency and quality of a specific work process.
- The tool chain as a whole improves the information flow between different work processes. Insufficient information flow is regarded as a main cause for unnecessary double work and inefficiency in industrial work processes.

In this paper, we focus on presentation of the diagnostic authoring tool. We intend to develop a tool that can be used (and therefore evaluated) under practical working conditions. In contrast, due to limited man-power and project run-time, the two other tools will be merely research prototypes to demonstrate the feasibility of the model-based approach.

3 THE DIAGNOSTIC AUTHORING TOOL GENESIS

Today's diagnostic authoring process of our application partner at Bosch can be characterized as follows:

- a pure text-based word-processing environment
- page-based storage and retrieval of document sections
- reuse of existing text pages, partly enhanced by parameterization
- external translation of new and adapted text pages in up to 21 languages
- reuse of text pages restricted due to
  - limited retrieval facilities, and
  - large (and thus context-dependent) text blocks

With GENESIS, we are aiming for the following improvements

- automated generation of document parts, in particular of test-plans. Expected benefit: Improved quality through guaranteed correctness. Consistency between electrical and hydraulic diagrams, test-plans, and tables within a document, due to identical underlying model (single-source principle).
- reduced number and size of text-blocks. Expected benefit: reduced translation costs and increased degree of reusability of text-blocks.
- semantic representation of service documents based on semantic representation of each text-block. Expected benefit: Knowledge-based support during authoring, hence higher productivity. In particular: Improved (i.e. context-dependent) retrieval facilities for text-blocks. Automated consistency checking. Fully automated conversion of documents to tagged (i.e. SGML-based) exchange formats, like e.g. J2008.
- explicit representation of authoring guidelines. Expected benefit: Increased homogeneity of service documents.

GENESIS is realized in two stages.

- GENESIS 1.0 supports traditional authoring, but offers additional support to the author, due to the semantic representation underlying service documents. Expected date of delivery: August 98. GENESIS 1.0 will be evaluated by our application partner at Bosch under real working conditions.
- GENESIS 2.0 integrates model-based generation of test-plans and other document parts, as e.g. tables with nominal values. Furthermore, it will include enhancements reflecting the evaluation results of Genesis 1.0. Expected date of delivery: Summer 1999.

Final Remark: At the workshop, we intend to give a demonstration of GENESIS 1.0 on a PC.