The General Motors Variation-Reduction Adviser: A Deployed System for Experience Management

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The General Motors Variation-Reduction Adviser (VRA) is an experience-management system currently in use in most GM assembly centers. Its purpose is to capture and communicate problem-solving events from various quality-control activities. The most important prerequisite to the success of the VRA project was having a community that was already sharing problem-solving experiences, mostly via written logs (within in plants) and weekly telephone conferences (between plants). The key insight for success of the VRA was to realize that nobody is motivated to "author cases" for future use, but everybody is motivated to communicate with peers during an investigative activity. The case-capture mechanism for the VRA evolved from its original concept (authoring structured cases) to the final design that focuses on recording communications during the problem-solving process. The resulting "textual case-based reasoning" (TCBR) system leverages smart search (ontology-guided search) to counterbalance the loss of structure in the case descriptions. A formal return-on-investment business analysis was created to justify the project, but the most convincing justification has been its current widespread daily use.

1 Background

There have been a variety of types of experience management systems in industry. A design adviser for Ford is described in "The Stamping Adviser" (Leake *et al.* 1999). The VRA is more closely related to problem-solving systems; for example, Ford's eBPR (Kwiecien *et al.* 2001), Schlumberger's Eureka/InTouch (McDermott *et al.* 2000), and Xerox PARC's Eureka (Bobrow and Whalen 2002). All of these have elements in common with the VRA: best practices, peer-to-peer sharing, and diagnosis. The main differences include the VRA's focus on manufacturing (including its community-of-practice-specific diagnostic ontologies) and the fact that its "best practice" functionality is peer moderated rather than "managed."

2 Task Description

Many aspects of the quality of automobiles are related to the consistency with which the basic frame of the vehicle is manufactured. If each body is perfectly congruent, then the process has "zero variation." However, there are usually small differences from body to body, and the dimensional-engineering (DE) teams in the plants have the job of "variation reduction," that is, making this variation as small as possible. The DE teams in GM assembly plants are the primary users of the VRA.

A DE team is usually divided into two or three consecutive shifts (8 hour periods), so that an issue identified in one shift may be worked on by subsequent shifts until it is resolved. At the beginning of each shift, the DE engineers typically need to be updated on progress and problems, and VRA "entries" function as a communication log for the DE team, so that an accurate written summary is available.

However, the VRA entries – when grouped into coherent cases – form a casebase, providing a "memory" of solutions and a repository from which "best practices" can be extracted and shared.

3 Application Description

The VRA was originally conceived as a classic feature-vector-based diagnostic case-based reasoning (CBR) system (Leake, 1996). After a long period of evolution (Morgan *et al.*, 2003), the VRA became a communications log with a textual CBR functionality. The main reason for this evolution was that "communications" had immediate benefit to the users and "case authoring" did not. Therefore, we had to modify the VRA system to subsume case authoring in a communication log. This strategy, although leading to less structured cases, has been successful in the sense of leading to a system that is used and that still generates adequate case records.

The VRA is organized around messaging "entries." Each entry has some structured attribute values (entered via pull-down lists) and also a block of free text. In particular, the symptoms of the problem are described only in the text, and therefore "search by symptom," the key mechanism of diagnostic CBR, cannot be limited to the structured data. Graphical attachments are optional, but useful. See (Morgan *et al.* 2003 and 2005) for screen shots and a fuller description of the user interface. As noted above, all entries concerning the same issue are grouped into a case.

The VRA architecture includes viewing and messaging subsystems, with a variety of domain-friendly features, support functions, a database of entries, and search and summarization functions. Also included are database and ontology maintenance functions.

The VRA was originally developed in English, but there is a Spanish version in use in two Mexican plants, and a German version is being tested.

4 Ontology-Guided Search

We have constructed an OGS engine to infer structure and inter-relationships on the free text without requiring the user to take on the additional burden of more complicated data entry. See, for example, McGuinness 1999.