

# A knowledge based system for predictive diagnosis and preventive maintenance

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**K**EYWORDS: intelligent monitoring, predictive diagnosis, data reconciliation, on-line real-time knowledge based systems, development tools, neural networks.

It is a matter of evidence that significant benefits in terms of operating costs and product quality may often be obtained by simply improving the plant operation and maintenance techniques, rather than introducing sophistication into the plant design or adding new expensive instrumentation. The "a posteriori" analysis of many typical mechanical or electrical failures shows that, in most cases, an "intelligent" and prompt use of the information available on the plant condition could prevent most of the damages to the equipment, reduce production losses and avoid product quality wasting.

These simple considerations are the basic idea on which, five years ago, the "Dimmi" project was launched as a part of an extensive research program to develop new industrial applications of the so called "Knowledge Based Systems" (KSB). To this purpose, a no-profit R&D joint organization (consortium) called "Sespi" was established in Naples by Italmimpianti (industrial engineering and contracting), Alenia (aerospace and electronics), O. Group (a software firm of Olivetti) and Datitalia (also software). 1991 to now, about 50 researchers and engineers have been involved into this program. In particular the Dimmi (Diagnosis, Intelligent Monitoring and Maintenance for Industry) project, has been defined and carried out in cooperation between the Sespi's Research Laboratory and Italmimpianti. As said above, the basic concept of the Dimmi system is to melt together into an organic environment all types of knowledge related to the management of a complex plant, i.e.:

- the engineering knowledge, consisting in physically based relationships, usually refers as "mathematical models";
- the "expert" knowledge, generally expressed

through rules or procedures reflecting the experience of the best skilled operation and maintenance personnel;

- the "self-learning" knowledge, based on a trial-and-error or statistical interpretation of historical data.

As a basic platform to build the Dimmi system, the Gensym's "D2" shell, a high level graphic environment for real time "expert" applications, has been selected. The integration between the G2 knowledge handling features and a set of originally developed tools allows Dimmi to approach in the most effective way the problem of optimising the maintenance-related aspects of a complex plant. Each of the types of knowledge listed above is to be treated by the most appropriate instrument:

- the G2 object oriented environment enables the process and rules description to be introduced in a nearly natural engineering language.
- an original, non-linear data reconciliation package, named *Expres*, has been developed to validate the plant measurements and to early detect any departure from normal operation.
- the Inference Engine allows handling of rule based knowledge made available by the operation and maintenance experts.
- fuzzy logic makes easier the treatment of problems and rules whose variables may be represented as probability distributions rather than single values.
- neural networks may be defined and used as alternative self-learning mechanism where neither physical or heuristic knowledge are available.

• a development interface, named *Dimmi Tool*, enables the developer to introduce in a fully guided, graphic way the fault detection trees, the related diagnostic procedures and the parameters for the data reconciliation.

To validate the new system, two industrial prototypes have been developed and installed in Italian steel works: the first one at the blast furnace n° 2, in Taranto works of Ilva Laminati Piani, the second at the walking beam furnace in "Unione" works on Falk. Both these applications achieved all the expected goals in terms of technical performances and economic benefits. ■



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