SMiRT-12 / K. Kussmaul (Editor)

SD106/5

STORING AND USING CASE HISTORIES AND OTHER POWER PLANT DOCUMENTS WITHIN AN INTELLIGENT HYPERMEDIA SYSTEM

A. Jovanovic[1], M. Friemann[1], E. Dias Lopes[2] and M. Vrhovac[2]

[1]MPA, Stuttgart, Germany
[2]ISQ, Lisbon, Portugal

ABSTRACT

The paper presents a novel approach for storing and using (in terms of cased-based reasoning analysis) of case histories and other power plant documents within an intelligent hypermedia system. Case histories are stored an object oriented database. Links to the corresponding full-text hyperdocuments are included.

1. INTRODUCTION

Practical power plant experience (Garleff, Dooley, Kautz, van Liere & Plate; Kautz & Zürn) confirm importance of various factors like uncertainty (scattering) in material properties, uncertainties related to oscillations of operational parameters like pressure and/or temperature in particular, etc.. Human expertise of different specialists is essential for the assessment, but is often unavailable at the plants in the very moment when it is needed. In its absence, the plant engineers, are thus often facing the question what to do with the component and/or plant (e.g. shut down and re-inspect, reduce load, etc.).

On the other hand, practical experience (Jovanovic et al., 1989) with expert systems has clearly shown that conventional (production rule based) expert systems alone can deal successfully only with a very limited range of practical problems in the above described domain. In addition the conventional systems are almost always interactive (dialog-based) and as such they often tend to "block" the dialog at the moment when the user is not sure what to answer the system, either because he needs an explanation of the question or because he is asked to provide (to the system) some additional information which is currently not known/available.

A possible answer to this and similar questions is to provide, by means of integration, all the tools necessary to avoid the above mentioned "blocking" of the dialog (e. g. numerics including finite elements, databases, etc.). This idea is the baseline of the MPA's approach called "KISS" - Knowledge-based Integrated Software Systems, or *K*nowledge-based *I*ntelligent Integrated *S*oftware *S*ystems. KISS allows different "weighting" of single elements (depending on the characteristics of a given application).

The approach can be illustrated by a power plant related example. A typical question in this application area would be (e.g.) "what to do with an old pressurized

component?". The component may be dangerous, people who built it may be long gone, a lot of data is missing, documentation may be in a poor state, ... still, the new component may be very expensive, its delivery time long, and, after all, why should one replace it if it still works, or can continue to work after a minor repair. The engineer's answer would then involve the following steps "asking" for an intelligent system (cf. Fig. 1):

a) Retrieve necessary data / information regarding

- material
- operational history
- loads
- applicable standards, codes, etc.,

KISS-support: "conventional" databases.

b) Retrieve necessary background data / information (the *"full text"*!) regarding

- applicable standards, codes, etc.
- similar cases (case studies)
- relevant literature

KISS-support: from hypermedia databases.

c) Make all necessary warnings, recommend solutions and support the decision

KISS-support: CBR-oriented knowledge-based systems

Integration of numerics, databases, hypermedia and object oriented expert systems within KISS has been discussed in preceding work of Jovanovic, Friemann and Kautz (1992). The integration of case based reasoning (CBR) would be a further evolvment of KISS (cf. Fig. 1) and it is discussed hereafter.

2. BASICS OF THE APPROACH

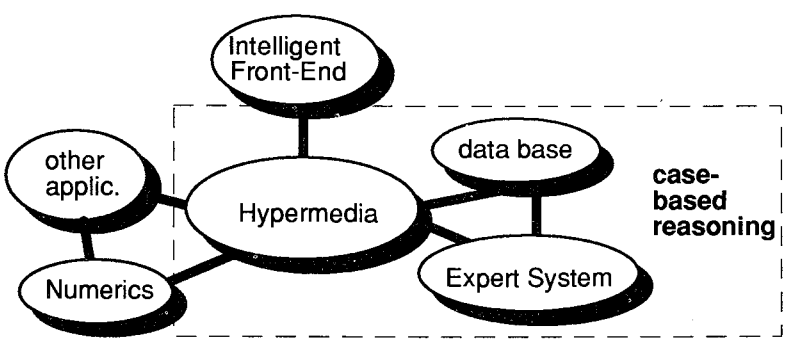

Fig. 1 Case-based reasoning in KISS

Case studies usually include the component description, inspection data and calculation results and some conclusions (the decision "what to do with the component"). The text normally includes figures, images and drawings.

Codes, standards and regulatory guidelines usually contain the same type of textual and visual information. Hypermedia (hypertext) is therefore an appropriate framework for such kind of information.

Both case histories and regulatory documentation are stored in a way shown in Fig. 2. Each hyperdocument has its "ID-Card". This facilitates retrieval and serves as the basis for CBR. In addition the KiSS is "aware" of the contents of hyperdocuments by including their features and their relations into the very knowledge base (Fig. 3).

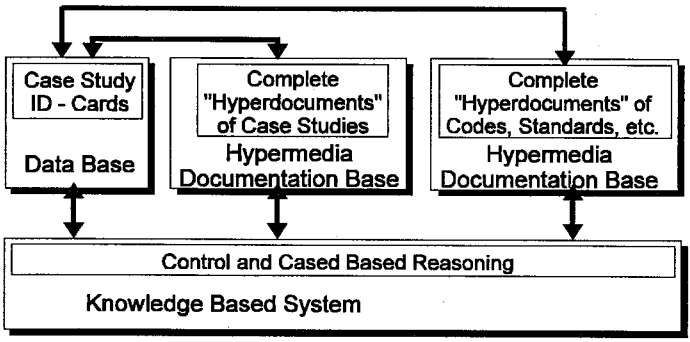

Fig. 2 Structure of the software system

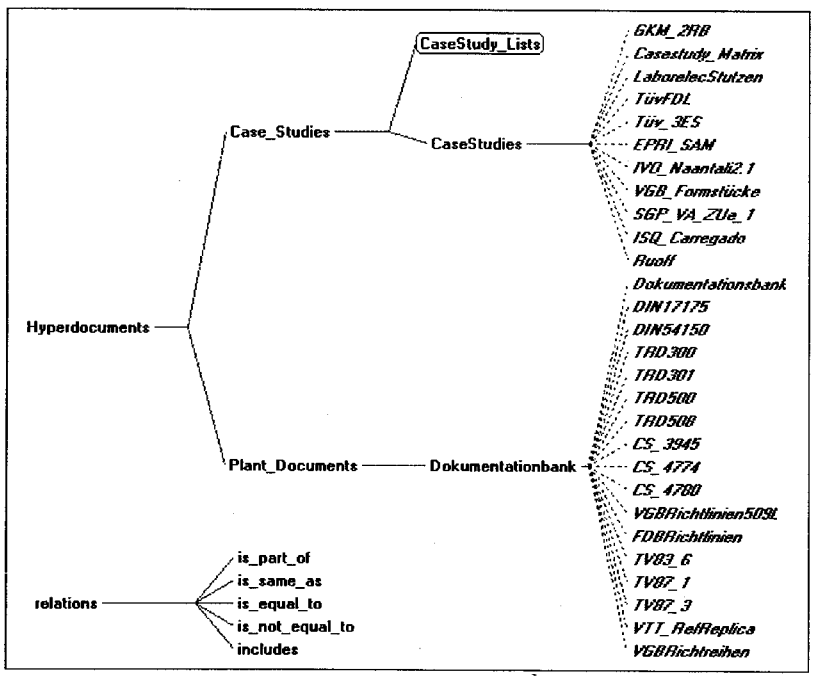

Fig. 3 Extract from the knowledge base: structure of the document object system and relations among the objects

Access to hyperdocuments (case histories, codes, etc.) is possible in different ways:

- in hierarchical way following the hypermedia user interface by using the Case study matrix which is a matrix of different materials and components(see Fig. 4).
- through selection of desired properties of the case(s) which the user wants to see. The system will then seek for matching cases and present them in a list.

By selecting in the list the user can then see properties and the full text document.

- The third way to work with the cases is to use the case based reasoning facility.

Compared to rule and model based reasoning Case Based Reasoning (CBR) is a rather new methodology used in science. Like other "AI" methodologies CBR tries to simulate the experts problem solving process.

User friendliness is given by using hypermedia documentation system with hyperdocuments which allow the incorporation of full text and images as well as the use of links inside the documents and to other documents. The system is built on Windows 3.1 so all advantages like mousing hyperregions can be used. A history of all previous seen documents is available.

3. Practical Applications: ESR and PITIE Systems

Examples of practical applications of the above described KISS principles are given from ESR (Jovanovic 1990) and PITIE systems.

The ESR project of MPA Stuttgart (ESR - *E*xpert *S*ystem for *R*emaining life assessment, or *E*xpertensystem für *S*chädigungsanalyse und *R*estlebensdauerermittlung) addresses the problem related to possible failures of high temperature pressurized components (piping, pipework subcomponents, etc., in power and other industrial plants. The ESR project at MPA Stuttgart is sponsored by ten electric utilities from Austria, Belgium, Germany, Finland, Portugal and USA.

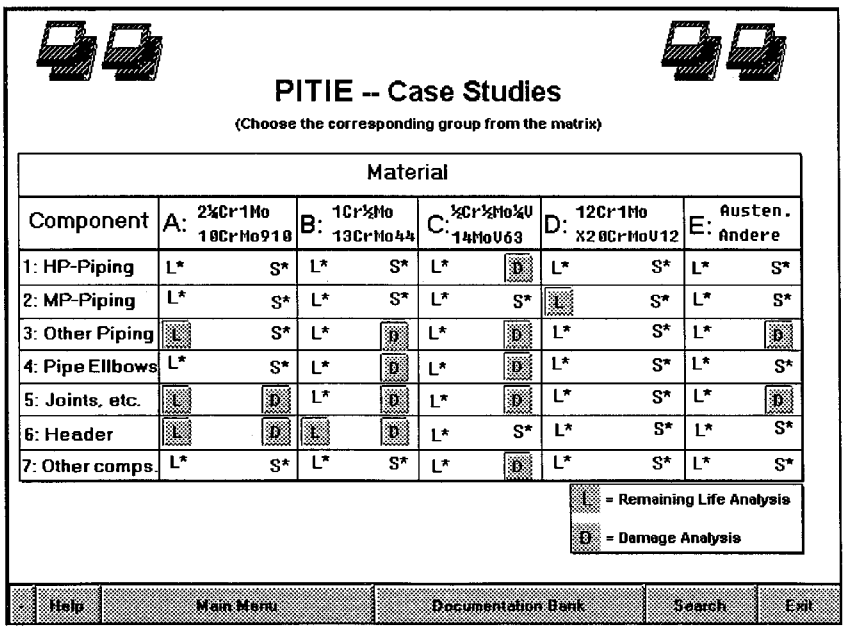

Fig. 4 PITIE - Case Studies Matrix

PITIE System (ISQ Portugal 1992) is currently being developed by ISQ Portugal under the consultancy of MPA Stuttgart. The system is designed as a combination of a database and a(hyper-) documentation base.

One way of retrieving case studies (via the matrix) is identical both in ESR and in PITIE (Fig. 4).

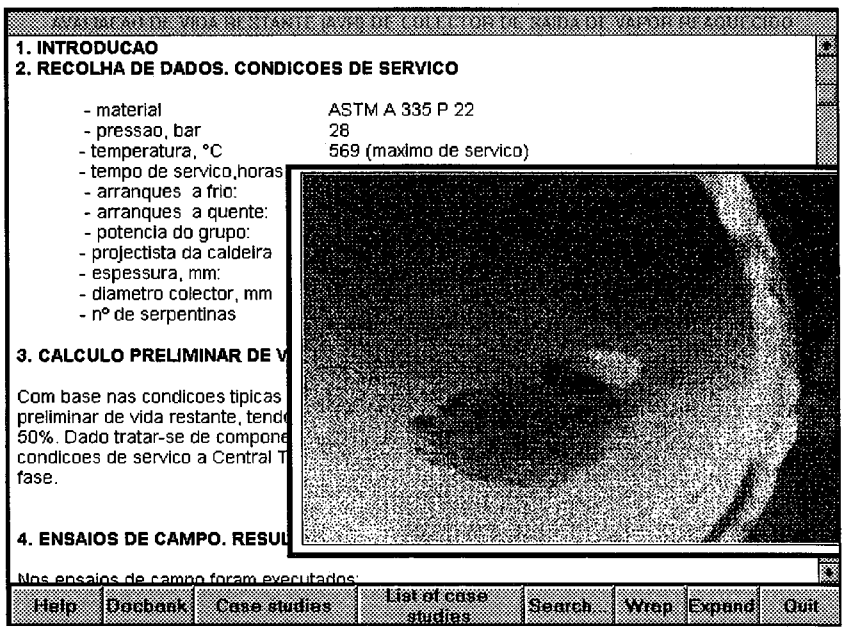

Fig. 5 Case Study in Hypertext form.

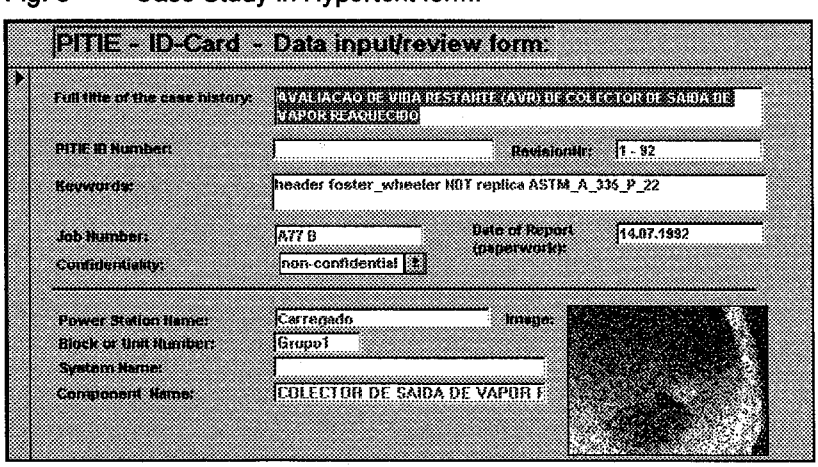

Fig. 6 ID Card for Case Studies in PITIE System

The matrixes (Fig. 4) contain combinations of component types, materials and types of case studies (remaining life assessment and damage analysis). Hypermedia allow incorporation of full text and images (Fig. 5).

Other two possibilities are (a) via the data base of the ID-cards (Fig. 6) and (b) via "geographical database". In the first option (a) the user defines search criteria (queries) and the corresponding set of case study ID-cards is selected. In the second option user does not make a query, but selects the corresponding case studies belonging to the selected power plant from the map of Portugal. The case based reasoning part of the system (currently under development) leans on the system of "ID - Cards".

4. Conclusions

The approach described in the paper, as implemented in two practice-oriented integrated intelligent software systems (ESR and PITIE) has proved the power of CBR when integrated with other techniques. Expected development of the software tools for CBR in terms of

a) better analogy evolution methods

b) better integrability with other KISS-components (DDE, OLE, DLLs)

will certainly help in achieving even better results in power plant applications of KISS in future.

References

Garleff, V.J, Dooley, R.B., Kautz, H.R., van Liere, J. & Plate, K.. (1988). Lebensdauerverlängerung - ein komplexes Planungsziel. VGB Kraftwerkstechnik, 69. Jahrgang, Heft 12, Dez. 1988.

Kautz, H.R., Zürn, H.E.D..(1987). Das Verhalten von Schweißkonstruktionen im Kriechbereich. DVS Berichte, Band 115, 1987, Düsseldorf: DVS Verlag.

Jovanovic, A., Kussmaul, K.F., Lucia, A.C. & Bonissone, P., Eds. (1989). Expert systems in structural safety assessment, - Lect. Notes in Engineering, Vol. 53, Berlin: Springer Verlag.

Jovanovic, A. (1992). ESR-A Large Knowledge Based System Project of European Power Generation Industry. Expert Systems With Applications. Vol. 5: 465-477

Jovanovic, A., Maile, K. (1990). ESR-Systems - Expertensystem für Schädigungsanalyse und Restlebensdauerermittlung, Zwischenbericht/Interim report. MPA Stuttgart.

Jovanovic, A., Friemann, M., Kautz, H. R. (1992). Practical Realisation of intelligent inter-process communication in integrated expert systems in materials and structural engineering. Proc. of the Avignon '92 Conference Expert Systems and their Applications (Vol. 2-Specialized Conferences). Avignon. pp 707-718.

ISQ Portugal. (1992). PITIE-Projecto: Um Banco de Dados de Componentes Críticos e Circuitos de Unidades Industriais com Sistema Perical de Apoio a Consulta. Lisbon, Portugal.