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WEAK INFORMATION SYSTEMS FOR TECHNICAL DATA MANAGEMENT

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Abstract

Daily operation of structures and plants requires to manage and integrate large amounts of technical information. Existing approaches span from "no integration" to "strong integration" based on a common data base or product model. We propose concepts and technology to develop types of information systems in the middle. We call them "Weak Information Systems". The basic concept is to add to the layer of existing information a new layer of multiple partial models of products and processes. INTERNET technologies are well suited for implementation. An example of information system for Dams management is presented.

1. INTEGRATION AND SHARING OF INFORMATION

The design and construction of large structures and plants produces large amounts of technical information. This amount of information may be stored and distributed through different media: some of it may be paper based while other items may be hosted into different systems in digital form. Note that there is a huge number of operational structures and plants. This means that the problem of re_engineering and integrating legacy information systems has fully to be taken into account. This information is used during the whole life cycle of the structure or plant from design to decommissioning. During the life cycle several classes of users need to access and modify the information (e.g. designers, maintenance people or safety managers), and require specific views of available information. Each view represents a specific way to access and integrate the data. E.g. a safety manager of a set of dams may need to access the available information (measurements, tests, past engineering evaluations, design documents) concerning a specific structure aiming to evaluate its safety status. On the contrary a responsible needing to interface authorities must access the information from the point of view of the bureaucratic process. An information system able to manage such kind of problems has to deal almost with the following technical requirements:

- sharing the information (between local and central offices as well as various partners);
- linking distributed sources of data;
- managing multimedia data
- providing technical solutions to deal with etherogeneous environments and supply common person/machine interfaces.

Moreover another fundamental constraint is the development cost, considering that, for operational structures, the problem is to deal with information sources as they did evolve in time. To reduce the cost we have almost to take into account the following topics:

- reuse existing data bases;
- reduce the development from scratch;
- provide evolutionary paths to the development of the system.

2. STRONG VS WEAK INFORMATION SYSTEMS

The existing approaches to deal with the above mentioned requirements span from solutions where no real integration exists (the pieces of information are collected, if necessary in digital form, and some indexing mechanism is superimposed) to strong solutions where a unique data base or product model is designed to act as a basis for integration.
We say that the second approach leads to "Strong Information Systems" and we argue that, between the "No Integration approach" and the strong integration one, we may propose concepts and technology to develop types of information systems in the middle. They may exploit the advantages of a more knowledge intensive integration than pure indexing, while avoiding the costs and the feasibility problems of the strong approach. We call this type of information systems "Weak Information Systems".
In the following we resume the comparison between strong and weak approaches.

Strong information systems	Weak information systems
Common data model	Multiple specific integration models
Data Base oriented architecture	Integration of multiple data sources through added integration layers
One shot design	Growing process
Redesign of legacy systems	Integration of legacy systems

The architecture of a weak information system [1,2] is composed of:

- a layer of information sources (data bases, computational programs, subsystems);
- an integration layer.

The integration layer is composed of the following sub-layers:

A. abstraction layer (information models)
B. communication layer between models and humans (computer-human interface);
C. communication layer between models and information sources.

The basic concept of the weak integration systems is to add to the layer of the existing information a new layer of multiple partial models of products and processes. Each model may include some sort of specific knowledge and acts as a way to structure and access the information according to a particular user view.
For instance, as we will see in the description of the DAMS DOSSIER system, we may access the information concerning the management of a large set of dams in service though the following models:

- a unique object (or a hierarchy of objects linked with part-of relations) models a dam and allows to link the related information (measurements, drawings, images, basic reference data, surveys, past safety evaluations, tests, design documents) which is spread into many geographically distributed data bases. This type of model provides services to a technician assessing the safety status of the structure;
- a hierarchy of objects describes the whole set of activities which constitutes the management process of dams in service. Though this hierarchy it is possible to access part of the same information linked to the previous model as well as other information such as laws, standards, company regulations.

The models act as specialised interfaces which provide help to access and structure the information in such a way that a synthesis of information is not a new packing of it but a set of links providing specific navigation paths.

3. THE IMPLEMENTATION THROUGH THE INTERNET TECHNOLOGY

The implementation of a weak information system may take advantage of the use of the INTERNET software technologies.
The main reasons for this choice are the following:

- the software components available in INTERNET are based on a client-server architecture and are available on various platforms. This makes easy the design of distributed applications integrating different environments;
- the technology is largely based on de facto standards which support the stability of the applications, the interoperability and the ability to evolve;

- the WWW distributed hypertext technology is a useful tool to develop the integration layer. This allows to manage in a straightforward way hypermedia documents. Moreover standard interfacing mechanisms like CGI allow to integrate existing data bases and applications;
- the hypertext technology by itself allows to write simple product and process models. With the same technology it is possible do develop standard person-machine interfaces and to link models to existing information bases;
- if more complex models are required, technologies like JAVA allow the development of object oriented models embedded into the distributed hypertext;
- finally many low cost software components may be exploited to reduce the development cost.

4. AN EXAMPLE : THE DAMS DOSSIER

The DAMS DOSSIER system has been developed for ENEL S.p.A, the Italian electric power Company, as a first trial release to access and integrate the information concerning the whole set of dams managed by the company. The organisation managing the problem is distributed over various geographical locations. The available information is distributed in many sites and central data bases collect specific types of data such as the data coming from the automatic and manual monitoring processes. The organisation has in charge all the activities related to the structure including safety management and production management.
DAMS DOSSIER has been designed as a WWW application, exploiting the INTRANET network of ENEL, to allow the user easily access the information necessary to the dams management procedures.

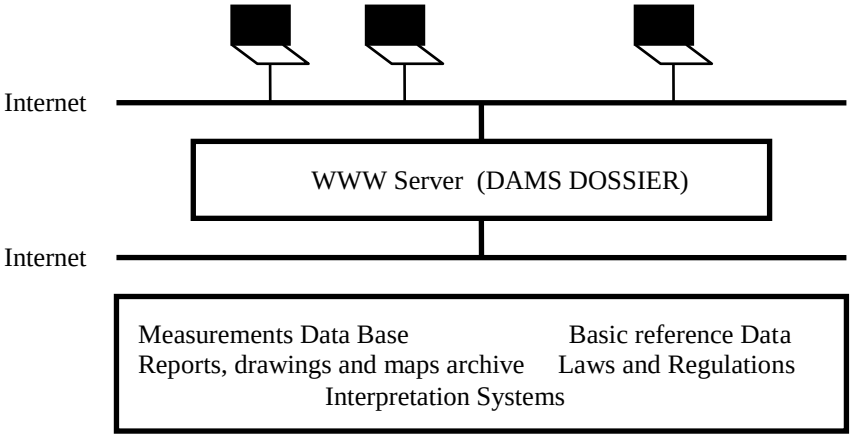

Fig 1 The architecture of DAMS DOSSIER

The kernel of DAMS DOSSIER (fig 1) is hosted on a processing system configured as Web server. The server accesses the remote data bases through the TCP/IP protocol, the CGI interface and, if needed, local Web servers. Users can access the application through standard Web browsers.
The system links many existing data bases hosted into several computers. The first release of the system integrates the following data bases:

- measurements data base (from monitoring systems or manual data acquisition)
- physical tests data base
- basic reference data (for technical and administrative purposes)
- document archives (safety reports, applicable laws, company procedures and rules)

Moreover the system may also access the real time data produced by intelligent interpretation systems which are linked to real time monitoring systems and provide real time evaluations of the safety status of the structure [3].
The integration layer includes the person-machine interface written using HTML and a set of simple models ,also written using HTML, which are visualised as icons in fig 2 :

- single dam; through this model the user may select a specific dam and access the whole set of data, spread through various data bases, which are related to the dam (fig 3). This model is mainly oriented to technical users aiming at evaluating the structural safety.
- set of dams; the model allows to navigate through data related to sets of dams and collects significant information related to a population of structures (e.g. for statistical purposes or economical evaluations).
- hierarchy of themes related to management procedures, laws, standards, company regulations (fig 4). This model allows a management oriented user to access the information required to interface local and

governmental authorities and to comply with the company regulations. The model may also link a specific subset of the available technical data.

Using the models the users may access multimedia information like texts, drawings, images and data records. For the current implementation simple integration models have been used. If required, more complex object oriented models may be added of the type described in [3]. E.g. a dam model may describe the dam as a hierarchy of objects (dam blocks, foundation, instrumentation system, sensors), each object including links to the available distributed information and methods to process it.

Fig 2 Icons to access multiple data bases for specific purposes

5. REFERENCES

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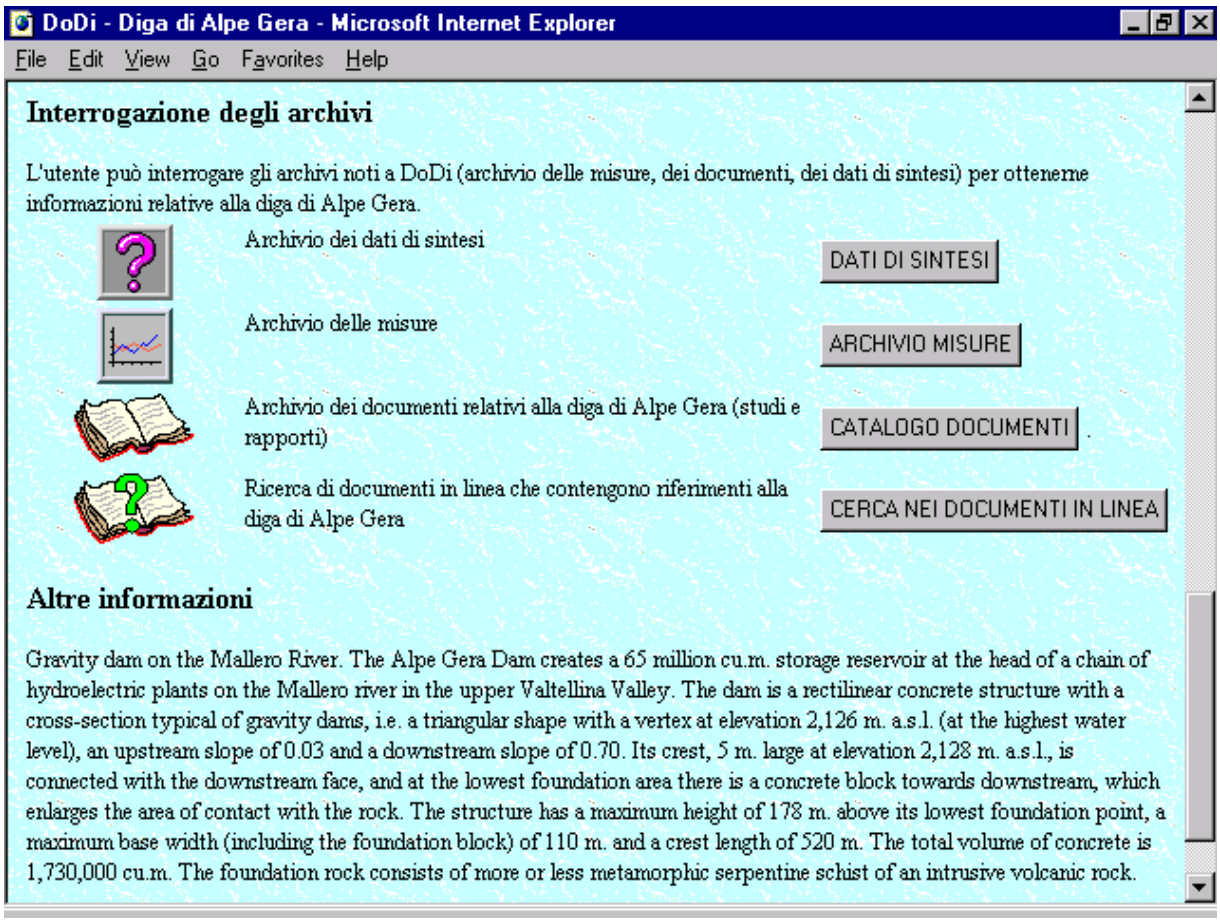

Fig 3 Access to the whole set of data related to a specific dam

Fig 4 Access to information related to management processes.