

WebDia - A WWW-based tool for diagnosing, servicing and operating heating systems

Jouko PAKANEN
Dr.
Senior Research Scientist
Jouko.pakanen@vtt.fi

Veli MÖTTÖNEN
M.Sc.
Senior Research Scientist
Veli.mottonen@vtt.fi

Mikko HYYTINEN
M.Sc.
Research Scientist
Mikko.hyytinen@vtt.fi

VTT Building and Transport
P.O.Box 18021, 90571 Oulu



Summary

WebDia is a service manual, a help desk and a diagnostic tool on the Web. Technically, it consists of a Web server and a PC or hand-held computer with an Internet connection, or a WAP mobile phone. The idea is that the server computer shares its resources and knowledge with the user. Diagnostic decisions suggested by the server are based on observations made by the user. WebDia is designed for ordinary customers, residential building owners, technical house managers and servicemen. The prototype system is constructed for district heating substations and oil heating systems. Besides diagnosis, instructions for servicing and operating the plant are other essential topics. The Web-based user interface is flexible. The presented information is not only hypertext, but also pictures, photographs, video recordings, and animations. So, the resulted information is comprehensive and easy to understand even for unskilled persons.

Keywords: diagnostic methods, Web-based tools, help desk, user interface, district heating sub stations, oil heating systems, WAP, hand-held computers

1. Basic features of WebDia

The diagnostic tool on the Web consists of a Web server on the Internet, a customer PC, a WAP mobile phone, or a hand-held computer (Figure 1.). The idea is that the server computer shares its resources and knowledge with the user. Due to its central role in the network, the server can continuously deliver essential, updated information to a large number of customers. The system is not electrically interfaced to any building or plant. The idea is that the user makes observations and reads process instruments according to the instructions given by the server. Decisions are based on interactive communication [1]. For now, customers can only access WebDia through a PC. In the near future, they will also be able to use a WAP mobile phone or a notepad computer with a wireless link to the Internet. This will enable them to use the system at the heating process site.

WebDia is a help desk, which is a basic type of diagnostic network [2]. Besides fault diagnosis, the help desk delivers necessary information about servicing and operating a plant. The next step in developing WebDia is to interface the server directly to the process or plant through a communication gateway and a building automation bus.

Designing a Web site, which consists of a large number of Web pages, requires a careful plan. Besides comprehensive representation and easy and quick access to all pages of the system, the



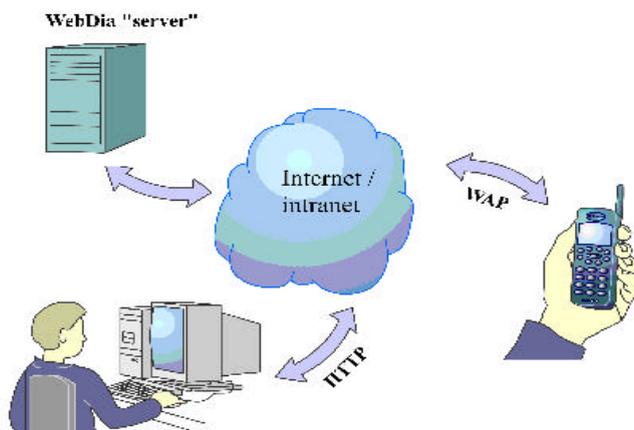


Figure 1. Operating principle of WebDia

collected data must also be easy to update and revise. One solution is to run all the data from a database system. WebDia is also a collection of dynamic HTML pages. They are implemented either by combining several elements into one page or creating page elements by executing embedded Java applets.

The information concerning heating systems is based on different kinds of publications, material provided by manufacturers and interviews with experts. In all the presented information, user safety and prevention of large (costly) plant failures are highlighted. Service actions and repairs not permissible for a consumer are clearly pointed out and he/she is advised to contact a professional serviceman.

Multimedia presentation is one of the basic features of WebDia. Multimedia techniques makes the available information comprehensive and easy to understand even for unskilled persons. By means of multimedia the required information can be presented in short form. A number of conventional Web pages can be replaced by one multimedia page. The applied techniques are hypertext, pictures, photographs, video recordings, and animations. WebDia can be found at the URL: <http://webdia.vtt.fi>.

2. Servicing and operating a heating system

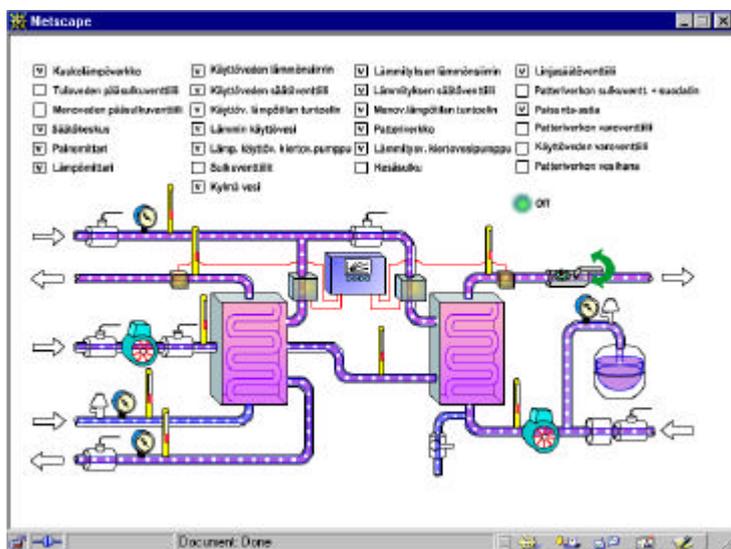


Figure 2. Animated district heating substation .

A consumer who is interested in finding out more information about his/her heating system may take a closer look at the process animations (Figure 2) to learn more about his own heating system, or to locate certain process equipment. If the user is not sure of terminology, he or she can consult a database describing most professional terms of the heating system. Questions concerning servicing and operating commercial process equipment like controllers, pumps, heat exchangers, boilers, etc. are linked directly to the Web pages of their manufacturers.

3. Diagnostic tools

WebDia contains several diagnostic methods: A look-up table, FAQ and a fault tree. The look-up table gives answers to a problem immediately, if the symptoms are clear and specific. FAQ is a collection of

One part of WebDia deals with servicing and operating heating systems. The information is presented using several techniques, mostly text, hypertext and pictures but also video and animations.

The service and operation pages concern either the whole plant or concentrate on specific equipment. They are designed for ordinary customers, residential building owners, house managers or professional servicemen. However, service actions and repairs requiring professionals are clearly pointed out to the user.

A consumer who is interested in finding out more information about his/her heating system may take a closer look at the process animations (Figure 2) to learn more about his own heating system, or to locate certain process equipment. If the user is not sure of terminology, he or she can consult a

answers to common questions concerning fault diagnosis, service and operation of heating systems. The fault tree procedure takes more time to go through than the others, but it is the most thorough tool for fault diagnosis. The diagnostic methods need no design or training data for initialisation. They do not need any direct interface to the process, but the methods do benefit from process information observed by the user. The category of diagnosed faults includes all the typical faults of district heating substations and oil heating systems.

3.1 Look-up table



Figure 3. WWW page of the look-up table.

The look-up table is designed for those who don't want to waste their time in exploring lengthy and thorough diagnostic methods. For them, a look-up table of most common symptoms and possible faults is a good choice (Figure 3). Besides symptoms and faults, the table simply gives advices and suggests some actions to be taken to solve the problem. Although common advice is to contact a serviceman or energy company, the look-up table also provides the user with many useful hints. If terminology or understanding the operation of the district heating system is a problem, the user can read the FAQ or consult the process animation Web page, which illustrates details of process operation .

3.2 FAQ

WebDia not only solves diagnostic problems, but also gives information about technical systems, terminology and operation. FAQ, well known to Web users, is also a practical tool in WebDia

and one choice in solving diagnostic problems. On the FAQ pages the user can find much practical information and hints for his/her case. The WebDia system is designed together with HVAC manufacturers. Therefore, many of the FAQs are linked to manufacturers' Web pages. By choosing the proper link, you will be directed to the manufacturer's Web pages, where you will find information about product types in your own process. The manufacturers are interested in providing users with information with which they can solve minor problems themselves or with a local service company, without phoning or contacting the manufacturer.

3.3 Fault tree

The third fault diagnosis technique of WebDia is a conventional fault tree, which uses dynamic Web pages. Implementation of the fault tree is based on the distributed applet approach. Distributed applets can execute application logic on client platforms. Sun's Java is one known representative of this approach. Applets, which are programmed using Java language, can be embedded into the HTML code of a Web page. Applets are first dynamically downloaded from the Web server by browsers capable of handling Java code. Then they are executed by virtual-machine interpreters running on the client. Java applets, downloaded and executed on the Web client's computer,

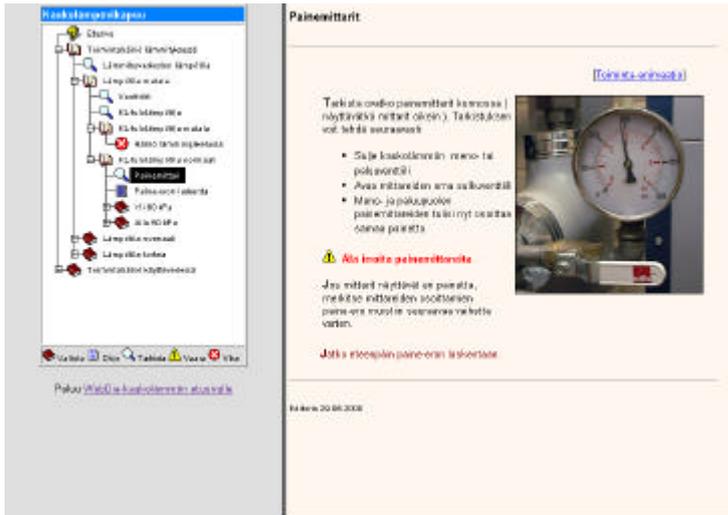


Figure 4. WWW page of the fault tree. The left side presents one branch of the fault tree. The right side is a separate WWW page instructing the user how to proceed. The illustrated page asks the user to check the condition of the pressure gauge.

can indirectly connect to back-ends through a Web server proxy. The applet itself can also directly interact with database and back-end services. The following implementation (Figure 4) is based on Della's TreeApplet v2.01.

4. Discussion and Conclusions

WebDia has been available to Web users for several months. According to the feedback, it has turned out to be a handy tool for servicing, operating and diagnosing HVAC systems. By using WebDia a residential building owner or an unskilled person can learn how to use and maintain his own heating system, or how to proceed if some problems appear. In case of technical problems, he or she can first consult WebDia and then call a serviceman, if necessary. After visiting the Web site, he probably knows more about his system and can better describe the problem to the serviceman.

A professional serviceman may need WebDia if he wants to check how to perform a rarely applied service procedure. WebDia also offers him easy and updated links to the Web pages of HVAC manufacturers.

For an HVAC manufacturer, a tool like WebDia may also turn out to be valuable. In the case of faulty HVAC systems, many people make a direct phone call to the HVAC manufacturer. Answering such phone calls usually loads their customer service. However, many of the phone calls are not relevant, because after a long discussion both sides realise that the reason for the fault is not in the manufacturer's equipment. Thus, such discussions may become shorter or even unnecessary if the customer is advised to consult WebDia first.

WebDia is not more than a prototype system illustrating features of Web-based service, operation and diagnosis of an HVAC system. However, the presented features and feedback from WebDia users show that Web-based techniques enable the creation of practical and handy tools, which are applicable even now. In the near future, when high speed wireless links are applied in mobile phones and/or hand-held computers, systems like WebDia may prove to be a necessity in the diagnosis, service and operation of HVAC systems.

5. Acknowledgements

This research was financially supported by the Technology Development Centre of Finland and the Technical Research Centre of Finland (VTT). Work was also contributed by the following Finnish companies: Oy LPM-Group Ltd, Oy Kolmeks Ab, Ouman Oy, Tac-Com Oy, S. Stenfors Oy, Honeywell Oy, Oulun Energia, Tampereen Sähkölaitos, Fortum Oil and Gas Oy, Li-Plast Oy and Oilon Oy.

6. References

[1] Pakanen, Jouko 1994. Interactive Fault tree reasoning of a District Heating Substation – A Practical Approach for Fault Location. Service Life Prediction and Maintenance of Building. 2nd Joint Finland-Japan Workshop. Oulu, 6th to 10th of June. Oulu VTT Building Technology. Pp. 81 – 92.

[2] Möttönen, Veli & Pakanen, Jouko 1997. On-line fault diagnosis using Internet and WWW-pages. Computers in the Practice of Building and Civil Engineering. Worldwide ECCE Symposium. Lahti, Finland, 3 – 5 Sept. 1997, pp. 362 – 366.