

THE INFORMATION RETRIEVAL SYSTEM OF "HEAT AND MASS TRANSFER" SOFTWARE COMPLEXES

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A project is discussed which is aimed at creating the International Center for certification of software complexes (SC), intended to for solving various heat and mass transfer problems. Information on the experience gained in the operation of an information retrieval SC system is presented.

Certification of software is, no doubt, an urgent problem and it is of vital importance for the independent states formed after dissolution of the USSR since formation of a privatized software market is impossible without development of a system for their comparative assessment. Therefore, in this article not only a project is suggested for creating an international center for certification of software complexes intended for solving various heat and mass transfer problems, but also information is presented on the experience gained in its operation and on various forms of its possible activity.

It should be stressed that creation of such a center is a central problem for "Termoinformatika" Association, which unites designers and users of mathematical models, algorithms, software systems, information and expert systems, databases and knowledge, computer-aided means for scientific research, etc. As president of "Termoinformatika" Association, the author of this article realizes all the complexity of solving the problem, including a set of scientific, pure programming, organizational, financial, information communication, juridical, and other problems. This problem has been clearly discussed at the Association's meetings and the discussions were extremely helpful for forming a generally recognized point of view. The author is therefore grateful to his numerous colleagues for their most valuable discussions which promoted creation of this project.

Let us consider more closely the creation of an information medium for exchange of data on software complexes in heat and mass transfer based on the Information Retrieval System (IRS) of "Heat and Mass Transfer" software complexes. In our opinion, the system must have five levels of information storage:

- a) the first level of information risk consists in the filling of IRS information sheets by the developers of software complexes, following a specially designed pattern;
- b) the second "visualization" level provides the possibility of watching PC commercials (animated films) which present mainly the results of solving thermal problems, obtained with a particular software complex;
- c) at the third "demonstrational" level users of IRS can access by themselves (in a dialoge regime) the SC service, operate the pre- and postprocessor (the data input-output system), and solve some practical problems;
- d) the fourth ("rating") level consists in storing expert groups' decisions evaluating the software complex, including specially ordered information on results of its testing by the developers of the SC;
- e) the fifth ("marketing") level consists in storing SC copies ready for delivery, including all the necessary documentation needed, technical, legal, etc. (at present the fifth level is desirable but is not necessary, since it requires thorough juridical preparation).

At present at "Termoinformatika" Association all five IRS levels are in progress. In our opinion, it is information accumulation and experience gained in operation at these IRS levels that are a necessary condition for starting the solution of the whole problem. It seems reasonable that the central database of the "Heat and Mass Transfer" software complex IRS be stored at the International Heat and Mass Transfer Center. The central database should perhaps incorporate the national databases, including regional ones (for large states like the Russian Federation), to bring potential consumers of SC closer to the information sources that characterize their consumer

properties. As far as I know, the desirability of creating such a common information medium in software service has been discussed at the International Heat and Mass Transfer Center.

Initial work on this problem was started in the USSR more than five years ago within the "Numerical Simulation of Heat and Mass Transfer Processes" subsection of the "Heat and Mass Transfer" Section of the Academic Board for Heat Physics and Thermal Power Engineering of the USSR Academy of Sciences and the "Theoretical Modeling and Experimental Simulation of Heat and Mass Transfer Processes and Stress-Strain State of Parts of Machines and Apparatuses at High and Low Temperatures" Subsection of the "Thermal Conditions of Machines and Apparatuses" Section of the Academic Board for Machinery Research and Processing of the USSR Academy of Sciences.

Since December 1986 a group of enthusiasts (who united into "Termoinformatika" Association in 1991) directed by the author of this article has developed and implemented (which is very important) the concept of creating an information medium for exchange of data on software complexes in heat and mass transfer. Development of the "Heat and Mass Transfer" software complex IRS follows the principle that consists in establishing friendly and confident relations, including mutual responsibility, with developers of software complexes and provides for using information and promotion materials and the software complexes themselves only by permission of their authors

In order to develop the first information storage level at the Scientific Research Institute for Applied Mathematics and Mechanics of the N. E. Bauman Moscow State Technical University an IRS of "Heat Conduction" software complexes was developed in 1988. Filling of the IRS database was carried out in 1989-1990 and resulted in the accumulation of 63 information items about software complexes developed by that time in the USSR to solve direct heat conduction problems. Identical Russian and English IRS were created for interaction with foreign partners. The IRS of the "Heat Conduction" software complex was tested extensively and was demonstrated at the All-Union Exhibition of "Heat Conduction" software complexes (Moscow, 1988), at the International Workshop "Application of Mathematics to Engineering" in Bulgaria (Varna, 1989), at the All-Union Exhibition of "Thermal Mechanics" software complexes (Moscow, 1990), at the Eighth All-Union Workshop on the Mechanics of Reacting Media (Kemerovo, 1990) at the Seventh International Conference on Heat Pipes (Minsk, 1990), at the Exhibition of the N. E. Bauman Moscow Higher School of Engineering in Czechoslovakia (Prague, Brno, 1990), and at the Third All-Union Conference on Problems of Meshwork Construction for Solution of Mathematical Physics Problems (Sverdlovsk, 1990).

The IRS developed is connected with a database containing: SC sheets including search keys, information on the source description itself, and limitation on access to the information (the file is organized as lists and can be formed as a dialogue with the system manager using a special regime); information on the logged users of the IRS, including data on permanent subscribers, forms of servicing them (for example, periodic updating and dispatching of the arriving information); access characteristics; statistics of inquiries for stored information, which determines the complete list of fulfilled inquiries for every retrieval and assessment of the IRS operation by the users; information on adjustment of the IRS to a specific field containing keywords, their grouping in accordance with semantics of the displayed notions, and specification of the form of their representation on the PC display.

The "Heat Conduction" IRS has two main environments: user and manager environments. In the user environment the dialog is organized for a retrieval request and the requested sheets are displayed on the monitor and/or printed. Thereupon, the retrieval request is formed by the users by indicating the necessary characteristics in the menu of a PC and information on relocation to a required topical field input into the system being used (Figs. 1-4). This approach is a characteristic feature of the developed system. When a query is executed, the system statistics is replenished as each data sheet delivered to the user is logged (Fig. 5).

In the manager environment a dialog is organized. Within the dialog access of the user (manager) to operation is determined, operation type is chosen (entry, updating, or elimination of data sheets, their printing, visualization and printing of statistics, setting and (or) resetting the system), a dialog procedure is realized for one of the operation types which, except for resetting, are realized as operation with frames of a "menu" type (see Figs. 1-4).

Operating experience has shown that creation of such systems is effective and reasonable if the number of stored items of information about the software complexes is more than several hundred. With this in view, the development of a thesaurus (keyword dictionary and glossary) of the "Heat and Mass Transfer" SC IRS is under way now. Presumably, it will contain more than several thousand data items.

For development of a common system of notions for various terms of the IRS an auxiliary reference "Glossary" system has been created and is used now. It allows the use of the same hardware, for example, for the "Heat and Mass Transfer" IRS.

To develop and accumulate the second and third storage levels of the information on software complexes in heat and mass transfer, since 1992 "Termoinformatika" Association has been arranging exhibits and conducting travelling exhibitions of "Heat and Mass Transfer-Thermal Strength-Ecology" software complexes. The "Heat Conduction" software complex exhibition at the N. E. Bauman Moscow Higher School of Engineering in 1989 attracted much attention from lecturers and researchers of higher schools and academic institutes and industrial experts. Meanwhile, it revealed some disadvantages of such a form of scientific communication:

- 1) the exhibition was similar to a scientific seminar, with extensive demonstration of the authors' developments on stands and PC displays, and it was visited mainly by SC designers;
- 2) the exhibits were research programs rather than completed commercial products.

The experience gained by a number of SC developers in other exhibitions, including international ones, showed that at general-type exhibitions (nonmathematical), the percentage of scientific programs was small and in effect, there was no commercial interest in problem-oriented SCs. Therefore, in order to increase a return from problem-oriented program promotion, it was suggested that exhibits for a travelling computer exhibition be arranged.

The exhibits at such exhibition may be shown by three different means: SC commercials to be demonstrated for up to 2 min which are combined in a single "ring"; SC information videoclips with a demonstration for up to 10 min which are shown by visitors' inquiry; SC demonstration options whereby the interested visitors themselves can evaluate the efficiency and attractiveness of the software complexes. Increase of the number of exhibited SCs has allowed "Termoinformatika" Association, which is the organizer of the exhibition, to carry out classification of the exhibits on the following subjects: heat conduction, convective heat transfer, radiation heat transfer, thermal strength, ecology, hardware. It should be noted that the great interest in our exhibition shown by the participants of The Second International Heat and Mass Transfer Forum in Minsk confirms the efficiency of the suggested form of scientific communication and arouses hope for increasing the number of exhibits and commercial interest in them.

Development of the fourth IRS level requires testing and comparative evaluation of SCs, the tests being conducted at two levels: the "mathematical" one connected with evaluation of confidence in using the mathematical model, algorithm, and computation methods; the "physical" one connected with evaluation of confidence in the physical model of the process considered using relevant experimental data.

Since 1992 "Termoinformatika" Association has been developing reference information systems for "mathematical" testing of SCs of various heat and mass transfer types. These systems can be used as computerized training systems in heat and mass transfer and thermal strength.

In conclusion it should be noted that "Termoinformatika" Association, whose members are highly qualified experts who gained extensive experience in development of IRS, is ready for implementation of this project and certification of SC in heat and mass transfer and thermal strength.

Copies made from PC monitors characterizing operation of "Heat Conduction" SC IRS are presented in Figs. 1-4.

ad. ad. ad. ad.

The "Heat Conduction" information retrieval system allows specifications of the stored application program packs and software complexes (SC) for calculation of the direct solid state heat conduction problems to be found, scanned, and printed.

Interaction with the system is realized as a dialog by selection of the required characteristics of the software complexes. If you are not familiar with the system, detailed information can be obtained by pressing the F1 key.

ad. ad. ad. ad.

Fig. 1.

To scan an SC, you should select the "Job for search of SCs required" mode and indicate its characteristics. Then, the sheets can be scanned and printed. If the sheets delivered do not meet your wish, change the retrieval job.

Job for retrieval of SC you need
|
Scanning the SC declarations - ? - Change of search job
|
Escape

F1, help

Fig. 2

Indicate the SC characteristics you are interested in
Function of SC
Physical statement of the problem
Numerical methods used
Specific features of the SC program-driven realization
Methods of entering information into SC and SC operation control
Output information forms

F1, help ESC, escape

Fig. 3

NUMERICAL METHODS USED
Numerical computation method

FDM	FEM	GEM	Others
Automatic construction of three-dimensional mesh domains			
	Yes	No	
Mesh work generation principles			
	Geometrical	Physical	
Account of meshwork adaptation to the solution			
	Yes	No	
Principles of automatization of selecting the time step			
For parabolic equations		For hyperbolic equations	
LAES solution method			
No solution	Direct	Iterative	
Iterative process organization (in nonlinear problems)			
	Yes	No	

Enter, element selection; End, selection end; F1, help

Fig. 4

An example of a data sheet of SC stored in the "Heat conduction" SC IRS data base is shown in Fig. 5.

DATA SHEET OF № 28 OF THE SOFTWARE COMPLEX
May 12, 1989
FEMHCA

"FEMHCA-2D" SC is intended for numerical solution of unsteady-state problems on thermal conditions of the parts of power units using the finite element method (FEM)

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Main characteristics of the software complex
 SC Functions

SC Type :UNIVERSAL
 :PROBLEM-ORIENTED

Physical statement of the problem

conjugation :RADIATIVE-CONDUCTIVE
 :CONVECTIVE-CONDUCTIVE
 dimension :ONE-DIMENSIONAL
 :TWO-DIMENSIONAL
 types of equations :ELLIPTIC
 :PARABOLIC
 coordinate system :CARTESIAN
 :CYLINDRICAL
 types of boundary conditions :I_p - T = T₀
 :II_{p-q} = Q
 :III_{p-q} = G (T - T_w)
 solid body characteristics :HOMOGENEOUS
 :COMPOSITE
 anisotropy :NEGLECTED
 nonideality of thermal contact :NEGLECTED
 phase transformations :NEGLECTED
 heat generation :NEGLECTED
 variations of the body volume :NEGLECTED

Numerical methods used

computation method :FEM
 construction of three-dimensional mesh domains :AUTOMATIC
 meshwork generation principle :GEOMETRICAL
 adaptability of the meshwork to the solution :NEGLECTED
 automation of time step selection :FOR PARABOLIC EQUATIONS
 LAES solution method :NO METHOD
 :DIRECT
 iterative process (in nonlinear problems) :CAN BE ORGANIZED

Information input

mode of operation :BATCH MODE

input source	:PUNCHCARDS :MAGNETIC MEDIUM :DATABASE
coder of three-dimensional parameters	:NOT USED
graphical finishing	:ABSENT
database	:USED

Information output

direct output to the alphanumeric printer	:AVAILABLE
accumulation on magnetic medium	:AVAILABLE
output information presentation	:TEMPERATURE TABLES FORMS :TEMPERATURE GRAPHS :ISOTHERMS :ISOSTRIPES

Program realization:

computer type (OS version)	:ÉL'BRUS (OS MVC)
algorithmic language	:FORTRAN :ASSEMBLER
accuracy	:ORDINARY
program management	:SIMPLE
peripherals	:DISPLAY :MAGNETIC TAPE :PRINTER :CURVE PLOTTER :GRAPHIC TERMINALS
SC mobility	:NOT PROVIDED
checkpoints	:AVAILABLE
special processors	:NOT USED
calculation date	:NOT IDENTIFIED