New Products & Technologies

MARC Assistance System Using Knowledge Engineering, "MARC-EXPERT"*

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1 Background of Development

A number of excellent engineering computation packages are available from software/hardware makers, relieving users from the burden of developing programs for individual problems. Such packages make it possible to execute high-level analysis in a comparatively short time simply by preparing input data.

Even in the preparation of input data, the manual of multi-function package is bulky and difficult to understand, and inexperienced users frequently require assistance from experts. Further, since the number of experts is small, sufficient support is unavailable and efficient operation is impossible.

Analysis work using the nonlinear structural analysis package MARC (a software package product of MARC Analysis Research Corporation in the U.S.) is executed in the sequence shown in **Fig. 1**, but this package also has the above-mentioned problem in preparing input data.

The MARC input data preparation guide system MARC-EXPERT (a name approved by MARC Analysis Research Corporation) has been developed to facilitate the use of MARC. This expert system requires no manual and no special training, and is used in support of input data preparation work.

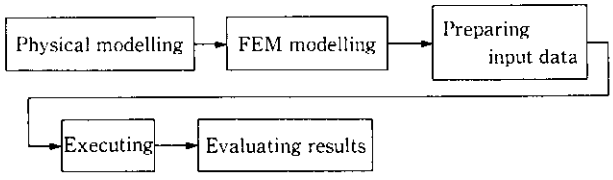

Fig. 1 Analysis operation sequence using MARC

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2 Outline of Processing

MARC-EXPERT is a knowledge-based system embodying accumulated information from MARC use manuals and expert know-how in the field of structural analysis, and offers the user guidance in the easy preparation of input data for executing structural analysis computations without the use of manuals.

MARC-EXPERT is composed of the following processes:

(1) A process which draws out the analysis conditions from the user, using a menu screens.
(2) A process which selects input data using input data selection trees.
(3) A process which outputs the input-data preparation procedure (input format, know-how and examples) from the knowledge base.

The outline of the interactive processing flow in MARC-EXPERT is shown in **Fig. 2**. Through this process, the user can obtain necessary, sufficient, and carefully-selected information for input-data preparation by inputting macroscopic analysis conditions.

3 Input/Output Functions

3.1 Input Functions

MARC-EXPERT asks questions of the user by means of menu selection regarding the following questions A to F. By answering these questions, the user can input the analysis conditions of the problem concerned.

A. Analysis field
B. Element type
C. Constraint
D. Load
E. Usage of computer
F. Assignment of output device

To improve the user interface, MARC-EXPERT is provided with an input mistake correcting function and HELP function (question item explanation function) as menu functions.

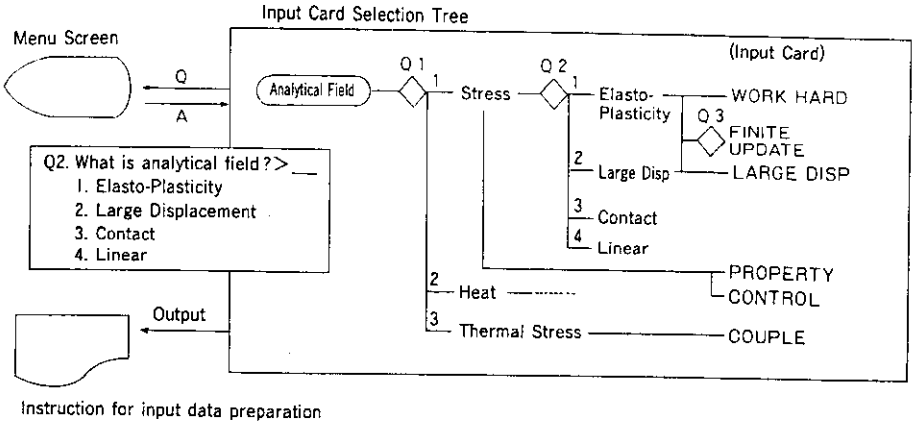


Fig. 2 Process of MARC-EXPERT

3.2 Output Functions

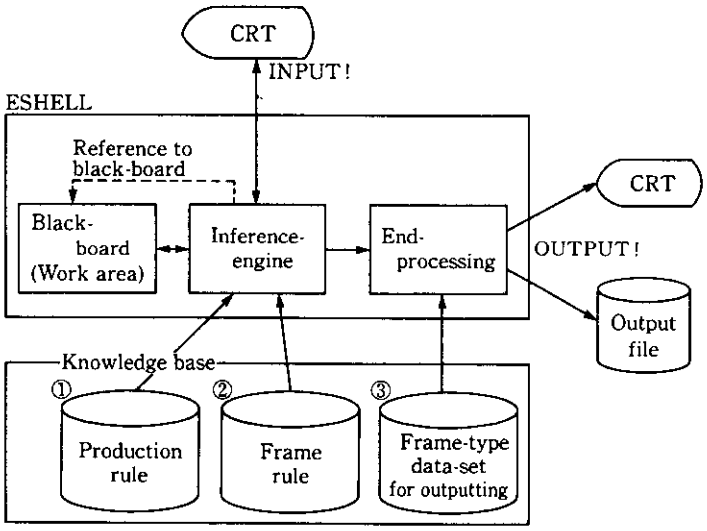
MARC-EXPERT selects the input cards necessary for the analysis and the element types from the knowledge base on the basis of the analysis conditions inputted by the user, and outputs the input-data preparation instructions for the input cards and element types, as well as an example.

Output items are as follows:

(1) Input Records of Menus: To be used for reviewing the input.
(2) Input Card List: A list of selected input data.
(3) Detailed Information for Input Data Preparation: Input data format and know-how for its use, as shown in **Fig. 3**.
(4) Example: Explanation of example and MARC input data list.

```
3.   FORMAT & KNOW-HOW

***** <P.C.> TITLE *****

     (FORMAT)

     ①   column 01-10: <A> TITLE
             "    11-76: <A> title for output reports

***** <P.C.> SIZING (work area) *****

     (FORMAT)

     ①   column 01-06: <A> SIZING
             "    11-20: <I> size of work space vector
             "    21-25: <I> maximum number of elements
             "    26-30: <I> maximum number of nodal points
             "    31-35: <I> maximum number of degrees of
                         freedom constrained
             "    36-40: <I> maximum number of elements in
                         the largest list of distributed load
             "    41-45: <I> element type #(1) → 72
             "    45-50: <I> element type #(2)
             "    51-55: <I> element type #(3)
                         <I>
             "    76-80: <I> element type #(8)

     (KNOW-HOW)

     No. 12-1: If the work area ≥100000 words,
               - set the number of words to the work area
                 variable INTS in the main program
               - replace the JCL: G#MARC to G#MARC

     No. 12-2: If the work area ≥1300000 words, REGION-
               OVER error will occur.
     No. 12-3: Notice elapse-time will go even though
               REGION-OVER occurs.
                    }
```

Fig. 3 Input format and know-how shown on the output reports



①Data Set for Knowledge Source :
Source for production rule. (Information necessary for outputs is issued by rules in this data set)

②Data Set for Frame-type Knowledge Tree :
Relevance of each knowledge in data set of ① has been expressed in frame structure.

③Frame-type Knowledge Base Data-Set for Outputting :
Storing locations for various normal data necessary for output.

Fig. 4 System composition

4 System Composition

MARC-EXPERT is broadly divided, as shown in **Fig. 4**, into the knowledge base, inference engine, and input/output section.

(1) Composition of Knowledge Base
The skeletons of the input-data selection trees (② in Fig. 4) and knowledge of input-data preparation instructions ③ are composed of frames. The operating section ①, which narrows down the input cards by asking questions through the route of the trees, is composed of rules.

(2) Inference Engine
The inference engine selects necessary input cards on the basis of the knowledge base (rule of ①) and frame of ②).

(3) Output
Using the selected input cards as key-words, information on input-data preparation instructions is retrieved from output frame ③ and output.

5 Operation Environment

At present, the MARC-EXPERT is operating in the following FUJITSU hardware/software environment:

Hardware: FUJITSU M series, Japanese-language terminals and local printers

Software: OSIV/F4-MSP, TSS, ESHELL, and UTILISP

For further application, an EWS (engineering work station) version of the MARC-EXPERT system, which open-ended knowledge base editor, is becoming available.