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## The Design of User-Oriented Fatigue Database Based on Client/Server Model

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**Abstract** A User-Oriented fatigue database based on Client/Server model was developed. The system structure, design thought and two key technologies on this database are discussed in the manuscript. The article's main content includes: Fatigue Database's structure; Client/Server technology; and Object-oriented technology. Several examples are illustrated at the end of paper.

**Keywords** Fatigue Database Client/Server Object-oriented technology

### Introduction

Mass information, experiences and achievements are accumulated with the research and development of fatigue technology. The question for resource sharing such as information, technology and application, etc. is an extremely urgent. The blossoms of computer technology in the field of database and network provide advanced tools and prerequisite for the establishment of fatigue database. Up to now, fatigue databases as well as computer aided fatigue has been focus on. A large-scale fatigue database named "Computer Aided Fatigue & Fracture Database" (abbreviation: CAF-DB) is established under network environment for the demand of mechanical designers and engineers on fatigue research since 1992. At the initial design stage, the system structure design, as well as the selection of developing tools and supporting technology, are based on the consideration of multitask, visualization, animation and remote-communication. The platform is based on multitask Windows environment because of its easy administration and favorable compatibility and solution for the program and algorithm, which need large memory. Visual developing tools (Delphi and Oracle), that support teamwork and possess favorable transportability and inheritance, give more convenient to database system designers and programmers. The adoption of Object-oriented and Data-flow-oriented technology guarantees the integrity of database system structure and system's reliability.

The following objectives are the main

investigating contents in the paper:

- ◆ The establishment of network environment of the database to satisfy the demand of resource sharing such as Information, technology, application, calculation.
- ◆ Provide of several database browsers such as Internet Explorer and CAF special Browser tools ;
- ◆ Provide of the analysis & simulation tools such as fatigue life prediction and estimation, structure reliability analysis, simulation of experiment process, analysis of experiment data, processing of graphics and artificial intelligent selection of material. etc.

### System Structure and Mechanism

As a large-scale fatigue & fracture database, comprehensive information is of necessity, moreover, it must provide practical fatigue analysis tools and database browser for user. CAF-DB system provides these two function. CAF-DB is consisted of Client (Module A, provide tools for user) and Server (Module B, provide data source) as following:

#### Module A:

**Database Browser:** Browse all the information of database (Data, Methods, Principles, Graphics etc.). Corresponded browse tools are provided and supported, IE(Internet Explorer), NetScape and CAF-DB professional browse tools which is used for the users working on fatigue field.

**Experimental Data Analysis Tools:** Analysis the experimental data, the results will be given by graphics, data and formula modes. At last, all the results will be saved into CAF-DB after inspecting and confirming.

**Structure Reliability Analysis Tools:** Analysis the structure's reliability.

**Real-time Simulation of Experiment Process:** The fatigue & fracture experimental process is reappeared in the way of data mode, text mode, graphics mode, image mode and animation mode, and It's experimental data is analyzed simultaneously.

Fatigue Life Prediction: Including various fatigue prediction methods such as safe life prediction, local stress-strain methods and energy methods, etc.

Graph Process Tools: Processing the experimental data, fits and draws curves, inspects and confirms while save result to database.

Image Process Tools: Recognition of Image (getting the curves from drawing paper).

File Manager: Manage the user's document, data and transform of file type (User format to CAF-DB format).

Module B:

Database Manage System: Manage, schedule whole database's running and operation

Material Base: Include all kinds of material's brand, performance and mechanical property data.

Specimen: Include all kinds of specimen's basic performance parameter and geometry shapes.

Curves Base: Include all kinds of fatigue and fracture curves such as S-N curves, Stress-Strain curves, etc.

Methods Base: Include experiment, analysis, calculation, math methods.

System Resource Base: Provide the necessary data for the normal operation of system.

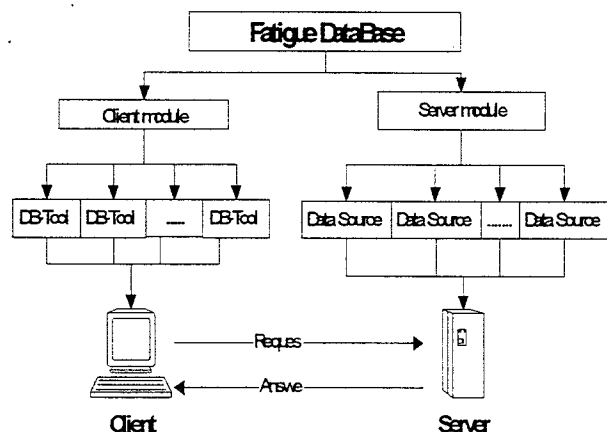


Figure 1 System Structure

Knowledge Base: Include all kinds of specimen and structure's compose formulae which will be used to artificial intelligence selection of material.

Module A provides practical tools, and Module B provides data source for Module A. DB-Tools shown in figure 1 stand for database tools, and Data Sources stand for the data source in database.

Client/Server model is the mainstream of current database technology, which is suited to establish large-scale database. According to the current situation of network and database technology, the system of CAF-DB structure based on client/server model was established (Figure 1). CAF-DB includes two part: Client and Server. User

can make use of the database's data by taking advantage of database tools. User can also interact with database to get information and data through client's tools. Client could be a personal computer, workstation or a terminal. User asks the server by using database tools, meanwhile, server that is one or a group of high-performance computer for manage and saving data responses user's request and answer the equines. Server engine inserts request into request queue while server accepts the user's asks, then database administration system search the corresponding data in database and return to client. The realization of communication between server and client is through network system which provides the communication service for client and server, so do the information visit and feedback. Module A is installed on client part of CAF-DB system and Module B on server. Then the communications are completed with the aid of network system and operation system. All Module-A's functions depend on Module-B's data source supporting.

### The Design of System Environment

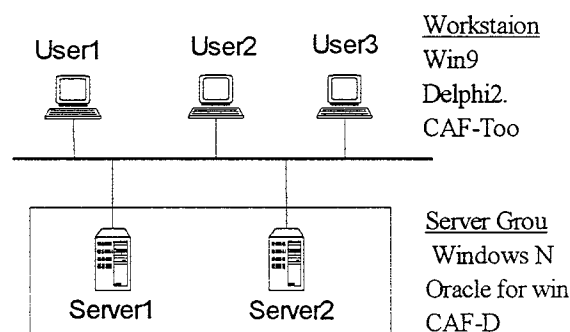


Figure 2 CAF-DB Test Network Model

The multitask operation system Microsoft Windows is chosen as developing platform of CAF-DB.

### The Network Environment of CAF-DB

During the process of development, a testing network that base on Windows NT platform was built, and also the Transmission Control Protocol/Internet Protocol (Abbreviation: TCP/IP) is adopted. Windows 95 is installed on client and Windows NT is on server.

### The Developing Tools of CAF-DB

Delphi (Client/Sever Version) that is one product of Borland company is utilized as client developing tool because of it's visualization and facility. Oracle for windows is utilized as server developing tool.

Figure 2 shows the testing network model of CAF-DB.

### Technique Routine

For the sake of guaranteeing system's integrity, life cycle software design technology, qualify control technology, Data-flow-oriented technology and Object-oriented technology are adopted. System's design strictly refer the life cycle software design method to guaranteed system's availability, dependency and maintenance. The life cycle software includes several process as followings: Problem, Analysis current background, Draft design, System design, Practicable analysis, Program design, Write codes, Test and Maintenance. System qualify control model is established to guaranteed the system's accuracy, reliability, efficiency, security, conjunction and freedom.

Advisable system's structure and the accuracy of data communication are guaranteed by adopting Data-flow-oriented design method, which is also, named as structure design methods. Proper data flowchart can be transformed to software structure. The accuracy of data is thus guaranteed when data pass each node of system. Reoccupy technology that is adopted in software design process is introduced into CAF-DB system's design so to support the cooperation of team-work, and also guarantee the module's dependency, interface's reliability and reoccupy. Current main software reoccupy technology is Object-Oriented technology.

Traditional Data-Oriented/ Procedure-Oriented (OO) neglected the internality between data and procedure. Various program has to be write so to satisfy same or various data deal though they have the same point in some aspect, and this kind of program have low reoccupy component. Object-Oriented technologies establish problem's model in the way of coinciding with human's thinking pattern to express the problem's solution directly. This kind of system can reflect problem entitative object component.

The utilization of Object-Oriented technology brings several features as following to whole system: Modular Structure: Modification in every module will not affect system's whole structure.

Be independent to system's running environment: Modular structure confines the part which depend on running environment within certain limits, and substitute the part with others while running environment is varied.

Standard and unified data interface: Standard data model can reduce the data exchange and dependence between module, when manipulating database, and concentrate the modules which is used to manipulate data into certain range.

### Examples

#### Low Cycle Fatigue Database and Browse Tool

Problem: Establish the low cycle fatigue sub-database and provide tool for user to browse the material mechanical performance, chemical component, low cycle fatigue properties,  $\epsilon$ -N curves and cyclic stress-strain curves.

Scheme: Material Mechanical Performance table, Material Chemical Component table and Low Cycle Fatigue Property table, which will be stored in CAF-DB server, is created and corresponding data input tools is also designed. All the information and data will be displayed in the form of table and graph.

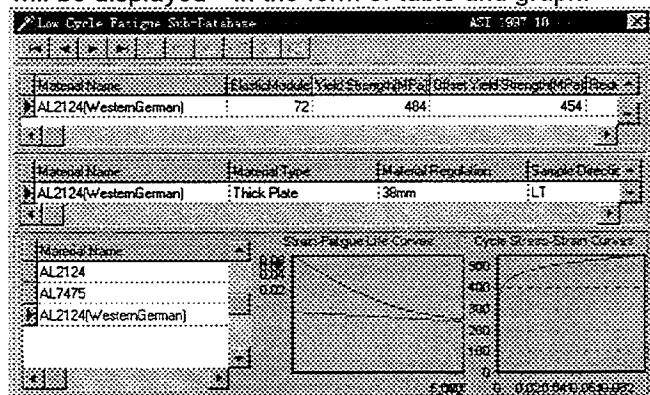


Figure 3

Data Flowchart: The data flowchart of this model refer to Figure 1. Model's structure is consisted of two part: client part (Browse Tool) and server part (the Material Mechanical Performance table, Material Chemical Component table and Low Cycle Fatigue Property table).

Interface Design: Figure 3 shows the program interface. User can browse, input and search data by utilizing the input tools and browse tool.

Code design: Generate the program flowchart according to data flowchart with the program document. Then write the program source code.

Test: Design the test data and scheme, then start up testing network, test this module.

Example: Figure 3 shows the Al2124 (Western German)'s mechanical performance, chemical component, low cycle fatigue properties,  $\epsilon$ -N curve and cycle stress-strain curve.

#### Load Spectrum Editor

Problem: Pre-process load spectrum in the visual way. Users can combine, insert, cut, cut, inverse, save and statistic the load spectrum. And

also the inadvisable values (Valley and Peak Value) are tackled.

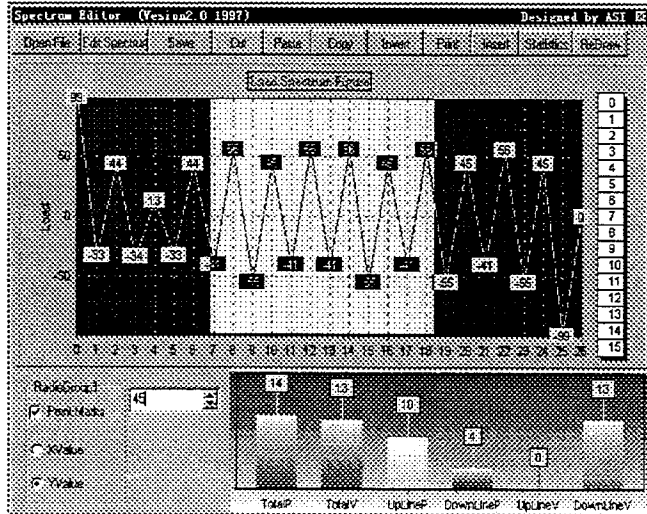


Figure 4

**Scheme:** List table that can store mass of load spectrum data is constructed. Mouse movement is also monitored so as to manipulated the spectrum shape.

**Design of Interface:** Figure 4 shows the interface of load spectrum editor. Users can complete all the manipulation (combine, insert, cut, cut, inverse and statistic the load spectrum) by utilizing the buttons and mouse.

**Code design:** The program flowchart and document are created according to the data flowchart. Then the source code is write.

**Test:** Write the test data and scheme, start up network system, test this module.

**Example:** A load spectrum shown in Figure 4 is editing. The main area shows the load spectrum shape, the right-bottom area shows the statistic result: TotalP: Total Peak Value number; TotalV: The total Valley Value number; UpLineP: The total number of Peak Value beyond "Load Level 45"; DownLineP: The total number of Peak Value below "Load Level 45"; UpLineV: The total number of Valley Value beyond "Load Level 45"; DownLineV: The total number of Valley Value below "Load Level 45".

Real Stress Strain Response Simulation under Loading Spectrum

**Problem:** Calculate and analyze the hysteresis loop shapes with different life prediction methods under loading spectrums.

**Scheme:** Display the calculating and analysis process in the way of data mode and graphic mode, User can also view the graph (hysteresis loop and

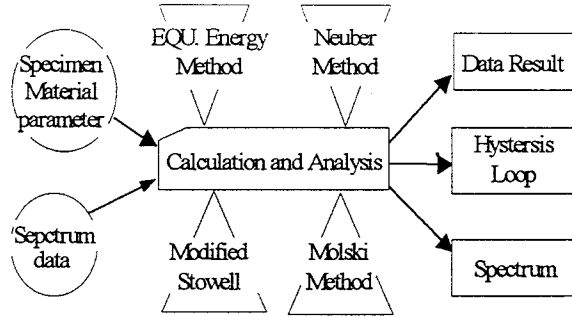


Figure 5 Data flowchart

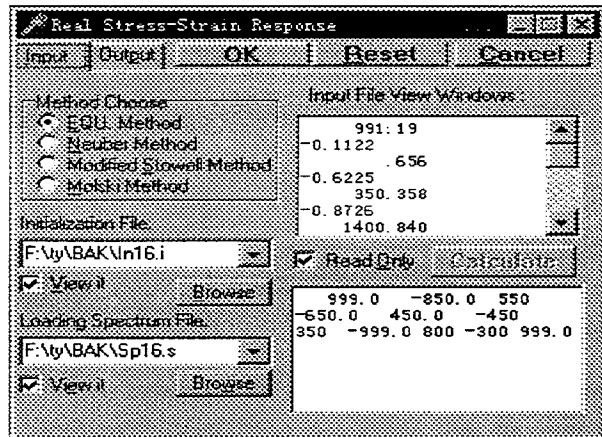


Figure 6a

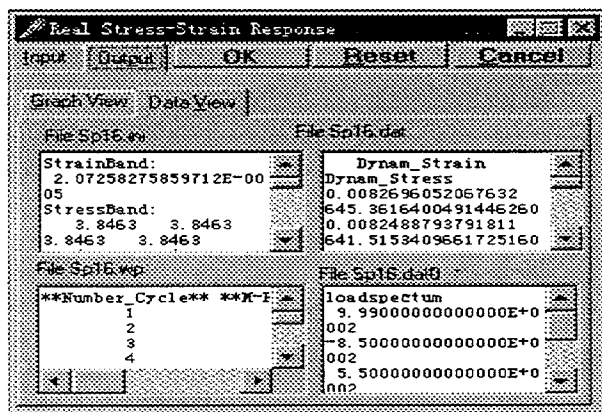


Figure 6b

spectrum) in detail . The program also possess the following function: Local stress-strain analysis by various methods such as Neuber, Modified Stowell, Molski and Equv. Energy.

**Data flowchart:** Figure 5 shows the data flowchart of program. Program structure is transformed from it.

**Interface:** Figure 6 shows the program interface. Figure 6a: Initialization; 6b, 6c: The Calculation Result.

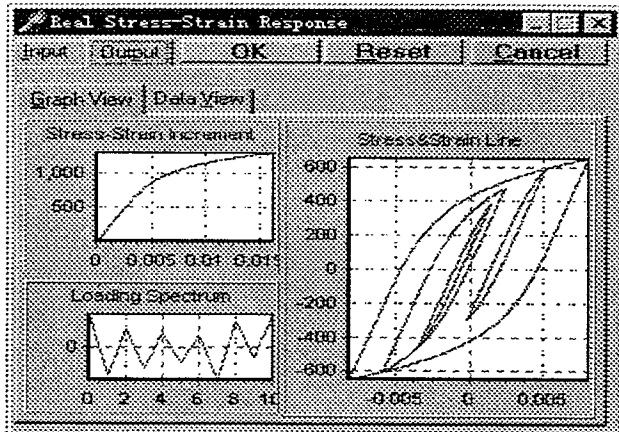


Figure 6c

**Code Design:** Generate the program flowchart according to data flowchart with the program document. Then programming source code.

**Test:** Design the test data and scheme (Various material, Various load spectrum and some extreme situation), then start up testing network, test this module.

**Example:** Figure 6 shows the response process of stress-strain (Initial data, calculation result and graph refer to Figure 6a, 6c and 6c.).

#### 5.4 The Design of Graphics Tool

**User demand:** To Transform the previous experimental fitted S-N curves or hysteresis loop curve recorded on paper into data file, then save the result data into database.

**Scheme:** Use scanner scan the graph and generate graph file, then use mouse to get the data point into data file, and imitate curve through math methods. Save result (Include data and curves) into database. This scheme is easy to realize, but precision is low.

**Data Flowchart:** Figure 7 shows the program flowchart. According each part's function corresponding objects are defined. For instance, the procedure "Read Graph into System" is defined as "Read Graph Object" which function is get the graph information into system and generate graph format data file. At each stage, modular document must be write for code design.

**Design of Interface:** The design principal of interface take intuition, easy to operate and sodality into consideration.

**Code Design:** Write the source code according to modular document base on the principle of software design standard.

**Test:** Design the test data and scheme, then Start up

testing network, test each module.

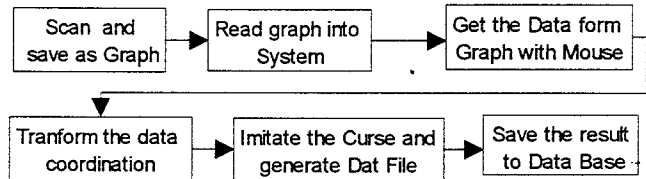


Figure 7 The flowchart of Graph tool

#### Conclusion

The design of CAF-DB is according to the standard of software engineering design. Up to now, the design of database structure and base client module has been completed. The next step is to connect the CAF-DB to the Internet and test.

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