Mechanical CAD Intelligent Engineering Database System Based on C/S Architecture

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Abstract. Computer-aided design (CAD) technology is widely employed in numerous sectors, including manufacturing, electronics, aviation, aerospace, and automobiles. However, the engineering database has practically become a scenario where it can only be accessible by CAD systems and cannot be amended by engineering specialists due to the high universality of CAD basic software. An intelligent engineering database for mechanical CAD based on client/server (C/S) architecture is presented to response the problem of mechanical CAD intelligent engineering database system. To begin, CAD architecture is utilized to implement database management, and a C/S knowledge integration system is built; second, it is separated into three primary modules: engineering database, expert system, and system integration. The database is built using the C/S architecture. Finally, the entities, types, and relationships described in the schema are translated into a set of data tables in the database using the provided conversion rules and implementation techniques. C/S architecture-based mechanical CAD The efficiency of adopting an intelligent engineering database system is 30% greater than that of a traditional database system, significantly reducing manual deployment time and improving overall system network performance.

Keywords: C/S architecture; CAD; Intelligent engineering; Database System promotion.
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1 INTRODUCTION

With the continuous development of CAD technology, CAD technology has been widely used in machinery, electronics, aviation, aerospace, automobile, clothing, construction and other fields. It is an important task for the project team of CAD Intelligent Engineering Database System to study the standard data of the manual, analyze the characteristics of engineering data and mechanical

knowledge, establish an engineering database and knowledge base that is easy to expand and transplantable, and realize the system integration independent of the specific application platform. As a sophisticated and popular technology, CAD technology is now widely used in enterprises and is the real productivity of enterprises [1].

The key work in the scheme formulation, calculation and analysis, optimization design, structural design (finite element analysis), engineering drawing, technical document preparation, simulated assembly and test, process preparation, automatic processing and production management of product and engineering design using CAD technology is related to the engineering data in this field. Experts can use CAD to make more precise design representations. Manual design drafting was replaced by CAD, which allowed for design creation, modification, and optimization. Engineers may create more exact designs and alter them electronically using CAD. The relationship between several materials is calculated using CAD software. Engineers, architects, designers, and others can use CAD software to generate precise drawings or technical images in 2D or 3D. When computer-aided design and Internet of Things data are combined, teams have access to a feedback loop on how goods are operating in the field, allowing them to build more dependable products [2].

However, due to the strong universality of CAD basic software, the engineering database has almost become a situation that can only be accessed by CAD system and cannot be modified by engineering technicians. Moreover, the engineering database does not contain many contents of engineering design. Therefore, these engineering data have become an important factor restricting product design. We conduct research and development of a mechanical CAD intelligent engineering database system, which is divided into three main modules: engineering database, expert system, and system integration, in order to solve this problem and meet the requirements of remote sharing and exchange of information among network users [3]. The database was built using a C/S architecture to increase the overall system's network speed in Figure 1.

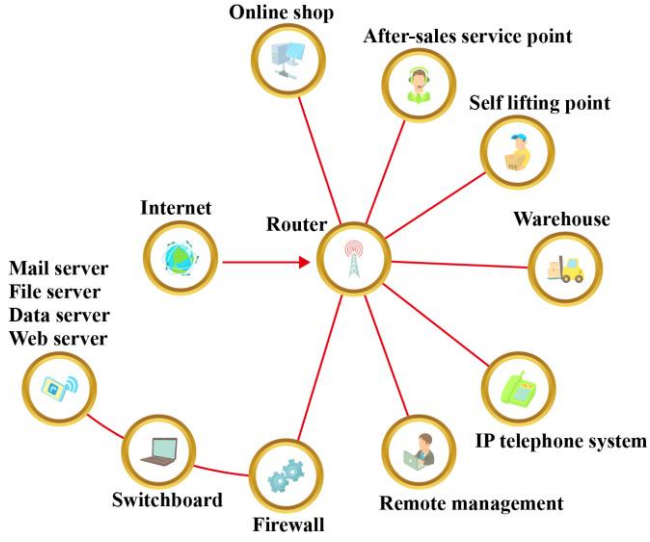

Figure 1: Mechanical CAD Intelligent Engineering Database System.

2 LITERATURE REVIEW

CAD intelligent engineering database system is divided into three main modules: engineering database, expert system and system integration. Collaborative design is to jointly carry out product development through the cooperation between relevant personnel in each stage of product

life cycle. At present, almost all mechanical engineering drawings are completed by computer aided design (CAD). The whole process of engineering drawings from scheme design to project completion is a dynamic and repeated process with frequent changes: Determination of scheme / drawing / review of competent department / change of drawings by the construction party during construction and manufacturing / return to the design enterprise for data modification, etc. The changes in this process are frequent and repeated, and the length of the cycle has seriously affected the work efficiency [5]. The competition of enterprises depends on the competition of products, the fierce competition and the cross regional development of the market, and the collaborative cooperation between different regions and different designers to make enterprises respond quickly, which is one of the key factors to win in the fierce market competition. Therefore, enterprises are required to establish CAD Intelligent Engineering Database with dynamic personality and easy to change data structure for collaborative design. Design is evolving in the areas of integration, intelligence, and automation in order to increase the capacity to adapt swiftly to market changes, small quantity, and multi-variety requirements. The goal of an intelligent [6] CAD system is to improve the application of artificial intelligence techniques in all aspects of the design process, particularly to organically combine expert system technology based on logical thinking with artificial neural network technology based on image thinking to improve the system's intelligence level. CAD is a software program used to create precise and accurate 2D and 3D designs. It enables the spectator to explore the artwork from multiple perspectives. The user may easily alter and modify the drawings. CAD is frequently used in combination with computerized industrial processes. Computer-aided design/computer-aided manufacturing (CAD/CAM) software is used to create products such as computer circuit boards and other electrical devices [7]. The characteristics of "network, integration, intelligence, and collaboration" in high-tech engineering development in a network environment, research and development has been integrated with engineering design development platform in which groups of people with various responsibilities participate [8]. Create a database based on diverse data from landscape construction. Flowers, trees, scenery, pavilions, road specialists, and so on should all be included in the database [9].

Friedlingstein, P. and others developed a hierarchical product data model, which is not only composed of basic product information (geometry, tolerance, assembly, etc.), but also contains organic processing information, such as cutting tools and processing parameters [10]. Callaway, C.W. and others put forward a data modeling idea according to the assembly relationship. It requires that the product is located at the top of the structure and the parts are located at the bottom. Each part contains geometry, tolerance, material and other information. This data model has poor scalability. Modifying the data of one part is easy to affect other parts of the model [11]. Negro, C and others proposed to realize product information exchange through neutral file data model, and believed that product model data exchange standard (STE) P could realize data exchange between CAD. They made a prototype system MDI [12]. Plessis, C. and others proposed a data model supporting CAD Integrated Information. The global data model is used to share all local information data models. Its structure is defined according to the step entity, and the necessary information can be retrieved from the global information model [13]. Since the development of CAD and CAM software, design and manufacturing processes have been combined. The concepts of computer aided manufacturing (CAM) and computer aided design (CAD) are similar. CAD software enables a direct link between CAD and CAM [14, 15]. A proper database management system (DBMS) is essential in order to make this database efficient. A CAD system's primary purpose is to create a geometric representation of a physical thing that is as close to its true shape and dimensions as possible [16, 17]. Premoselli and others proposed a data model of CAPP system. Its information is obtained directly from the target file rather than the general product model. A product modeling system supporting detailed design is defined [18]. Geocadin, R.G. believes that the initial design stage of the product has a great impact on the development of the whole product. Therefore, the data model system he developed mainly supports the conceptual design of the product [19]. Tucker, C.M. and others proposed a product data model using step. Its design and implementation are designed according to step standard, and supports product information structure and standard data format [20]. Easltnan first described a database that can

be used for CAD, which has a significant impact on the field of CAD [21]. Hellmann, R. a database management system for minicomputers developed by the laboratory for pihilkon system [22]. Phidas architecture is consistent with ansi-3 mode and cannot directly deal with complex objects. It is an original engineering database management system [23]. Because current developments in concurrent engineering lead to systems where not only design jobs access design data, but any application with a sufficient perspective of the design, database handling for CAD systems is required. The geometry and topology are stored in a data structure. CAD/CAM stands for computer-aided design and manufacturing. The CAD database is a file that contains part information. An appropriate database management system (DBMS) is necessary in order to make this database efficient.

Based on the current research, an intelligent engineering database for mechanical CAD based on C / S architecture is proposed [24]. Client-server architecture is a discrete event simulator in which the server hosts, delivers, and manages the bulk of the resources and services for the client. In this configuration, one or more client computers are linked to a central server through a network or the Internet [25, 26]. Connect to the internet. Because all requests and services are transmitted through a client-server network model or client-server network, networking computer architecture can sometimes be described as client-server architecture [27, 28]. A mechanical intelligent engineering database system based on the CAD structure of a C/S system can provide network users with convenient tools for exchanging and exchanging information. Using C/S architecture-based mechanical CAD Intelligent Engineering Database System has been found to improve performance by 30% compared to conventional database systems, drastically reducing manual deployment time, and improving network performance the whole system [29].

3 MECHANICAL CAD INTELLIGENT ENGINEERING DATABASE SYSTEM BASED ON C / S ARCHITECTURE

3.1 CAD Intelligent Engineering Database System

3.1.1 Database for mechanical design expert system

Because mechanical product design is a materialized process in which designers' creativity interacts with environmental conditions, it is an intelligent behavior. Therefore, in the design links such as the determination of product design scheme, the establishment of analysis model, the decision-making of main parameters, the design of geometric structure, evaluation and selection, there is a considerable amount of work that requires designers to give full play to their creativity, apply multidisciplinary knowledge and practical experience, analyze and reason, use decision-making and comprehensive evaluation, so as to obtain reasonable results. The expert system based on mechanical domain knowledge is helpful to solve this problem [30]. The intelligent CAD system integrates the engineering database and its management system, the knowledge base and its expert system, and the anthropomorphic user interface management system as shown in Figure 2. Expert system is a branch of artificial intelligence. It uses a lot of professional knowledge to solve problems that only experts can solve. Knowledge base and inference engine is the core of expert system. The key to establishing knowledge base is how to express knowledge, and inference engine is used to determine the method of imprecise reasoning [31].

3.1.2 Hybrid knowledge representation and hierarchical knowledge base model

In general, the problem area in an expert system (the area where experts can successfully solve a problem) is usually larger than the scope of knowledge (expert knowledge to solve a specific problem). There are many types of knowledge in the field of mechanical design, complex structure, product design knowledge and evaluation decision-making knowledge. In addition to domain knowledge and expert experience, it also includes various engineering drawing libraries, manuals, charts, formulas, basic databases, method libraries, etc. If different knowledge uses different methods of description, it requires a suitable mental engine, which increases the complexity of the

rationale and places higher demands on the acquisition of knowledge and the structure of the knowledge base. [32].

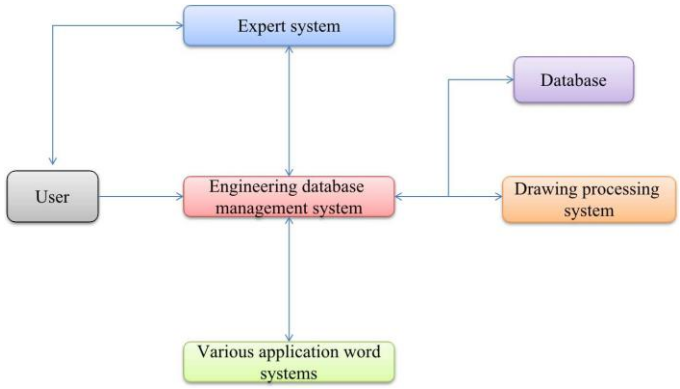

Figure 2: Intelligent CAD systems.

It can be seen that using a single knowledge representation method is difficult to meet the requirements. In order to develop strengths and avoid weaknesses, the mechanical CAD intelligent engineering database system organically combines the three representation methods of rules, framework and process, that is, the mixed knowledge representation method is adopted to adapt to the description of different types of knowledge in design. Among them, rules are the main body, supplemented by frameworks and processes. Frameworks are connected by rules. Similarly, processes are also connected by rules. The domain knowledge and expert experience used in mechanical design can be better represented by rules, the data chart can be represented by framework, and the process can be used to represent the functional relationship. According to the characteristics of multiple processes and decomposability of design objectives in mechanical design, on the basis of integrating various knowledge representation forms, various representation methods can be organically combined by meta knowledge control and hierarchical knowledge base model, and corresponding methods can be adopted according to the characteristics of different types of knowledge in mechanical design, so as to simplify the reasoning mechanism and improve the reasoning efficiency [33]. As shown in Figure 3.

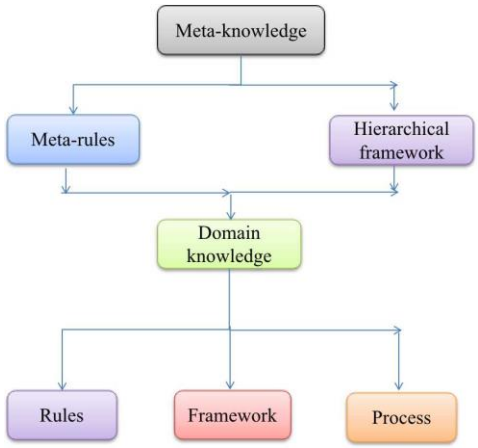

Figure 3: Hierarchical knowledge base model.

3.2 Mechanical Model Based on C/ S Architecture

3.2.1 Basic structure of client / server

The client / server system takes the database service as the core, and forms multiple computers connected in the network into an organic whole. The client and the server complete different functions respectively, such as client management user interface, receiving user data, processing application logic, generating database service requests, and then the client sends these requests to the server, receives the results, and then returns them to the user in a certain format; The server accepts the request of the client, processes it and returns the results. At the same time, the server checks the integrity of the database, maintains the additional data of the database, supports concurrent access control, and also restores and optimizes the processing of query and update [34]. Client administration user interface, receiving user data, and executing application programming are all functions that the client and server do separately. The design of a computer network in which numerous clients (remote processors) request and receive services from a centralized server is known as client-server architecture (host computer). Client computers offer an interface that allows a computer user to request server services and view the results returned by the server. Experts can use CAD to make more precise design representations. Manual design drafting was replaced by CAD, which allowed for design creation, modification, and optimization. Engineers may create more exact designs and alter them electronically using CAD.

C/S architecture adopts C/S architecture and provides database development based on C/S. It mainly has the following advantages: providing seamless integration of data and services. Through the database management system of C/S architecture, the integration of database and application can be easily realized and provides high performance for online transaction processing. Because the C/S architecture reasonably divides the functions, evenly distributes the load of the client / server, reduces the network transmission, and reduces the processing tasks of the client 4C machine. Therefore, C/S structure can provide high transaction throughput, short response time and support multi-user operation for online processing [35] as shown in formula (3.1):

$$\begin{Bmatrix} x_1 = x_3 \\ x_3 = f_\theta(X,t) + g_\theta(X,t)u(t) + d_\theta(t) \\ x_2 = x_4 \end{Bmatrix} \tag{3.1}$$

1. Openness and extensibility: C/S structure provides open client interface and open server interface, so that the client-side development tool of an enterprise can easily connect with the database server of another enterprise through 512c open database interconnection as shown in formula (3.2):

$$net_j = \sum_{i=1} w_{ij} x_{i(t)}, i \neq j \tag{3.2}$$

2. C/S distributed computing model in the C/S distributed computing model, especially the middleware model, as shown in the figure is the most reasonable. Middleware is a concept generated with C/S computing. It is an intermediate layer of software in C/S system, which is mainly responsible for transparent connection between client and server [36].
3. Middleware in C/S system can separate users and developers from different operating systems and communication protocols, while data can flow between different hardware platforms and application processes residing on the platform. So as to effectively reduce the workload caused by platform differences and shorten the system has development cycle as shown in Figure 4.

Figure 4: Middleware model.

4. C/S architecture deals with database management. In the process of dealing with database management with C/S architecture, the appropriate implementation of C/S model can reduce the cost of software maintenance, increase the portability of software and promote the improvement of existing network performance as shown in Figure 5 [37].

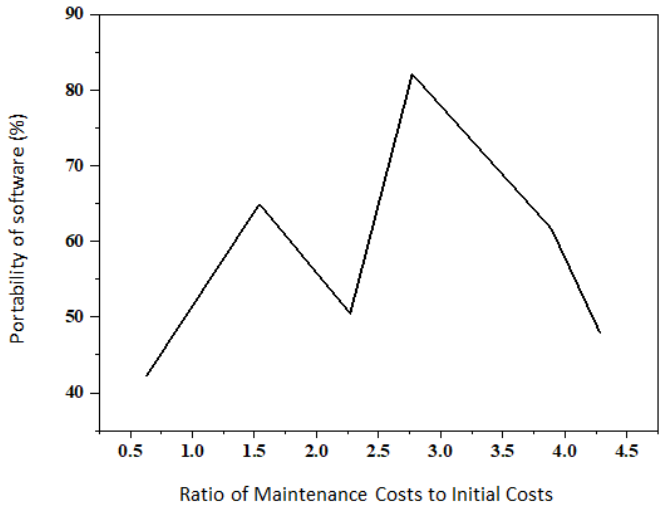

Figure 5: C/S architecture processing database management and maintenance cost relationship.

3.2.2 Database development tools

In the development environment of C/S architecture, the end database platforms include Infomix, Sybase, Oracle, SQL, server, etc. we choose Microsoft sqlserver2000. Because it is an efficient relational database system, which is closely integrated with operating systems such as Windows NT/2000. This arrangement enables SQL Server to make full use of the characteristics provided by the operating system and contribute to the development of complex client/server systems. More importantly, on the basis of inheriting the superior performance of MicrosoftsQLServer7.0, it expands the original OLAP (Online Analytical Processing) service component and renames it as AnalysisServicer, which greatly improves the analysis ability of this service [38]. The excellent performance of solserver2000analysis services is mainly reflected in the following aspects:

1. Data mining technology is used to analyze the data in celestial database and OLAP multi quasi data set in order to find interested information. When implementing the new OLEDB (object link and embedded database) specification for data mining in an open and extensible way, it incorporates the data mining function of sqlserver2000 analysis services. Sqlserver2000 includes data mining algorithms developed by Microsoft R & D center [39].

2. Provide greater flexibility in controlling access to cube data, and provide other authentication methods and enhanced role execution capabilities.
3. The enhanced pivot 'table service provides new connection options and supports the new cube and security features introduced in SQL Server 2000 analysis services. Other new features in the PivotTable service can be used by client applications when connecting to the analysis server or working offline.

As a result, Microsoft SQL Server 2000 has become an excellent database platform for large-scale online transaction processing (OLTP), data warehouse and e-commerce applications. We choose this platform to build server-side database, which is helpful to improve the performance of mechanical CAD intelligent engineering database system, and it is also convenient to integrate the system with Internet/Intranet.

4 EXPERIMENT AND ANALYSIS

4.1 Mechanical CAD Intelligent Engineering Database System Based on C/S Architecture

4.1.1 Implementation method of STEP standard

The method of implementing the STEP standard is a method of data exchange, which specifies the form and format used to exchange data in a particular field. The STEP standard provides various forms of implementation for the exchange of product information. Other ways to implement product data can be divided into physical file implementation methods, SDAI implementation methods for standard data access interfaces, database implementation methods, and database implementation methods. The more advanced ones are the physical file implementation method and the SDAI standard data access interface. The national standard number corresponding to Section 21 of China is GB / T16656.21. There are currently no national standards for the last three implementation methods [40].

4.1.2 Implementation method of physical file

The implementation method of physical file mainly specifies the format of writing the data described by step application protocol into electronic file (ASCII file). This format must be followed when developing step interface software. The standard specifies the contents of file header and data segment of step physical file, entity representation method, data representation method, mapping method from express to physical file, etc.

4.1.3 Implementation method of SDAI

SDAI realizes data exchange through the standard data access interface, and provides a standard application port for operating the data defined by express. The SDAI text structure of step mainly includes three parts:

1. SDAI environment: data dictionary model, session model;
2. Abstract data model SDAI operation;
3. Environment, version, repository, model, type, entity utility instance, aggregation, etc;

4.1.4 SDAI late binding library

Late binding library includes dictionary operation, data file I / O operation, aggregation operation, entity operation, basic type operation and environment operation.

1. Dictionary operation: it mainly includes data dictionary loading, mode, type, entity and other operations, and provides query operations for mode content definition, type definition and entity definition [41].
2. Aggregation operation and accumulator: aggregation can be divided into table, array, set and package. It is realized by template. In fact, it is a parametric type. The accumulator is also realized by template.

3. Instance operation: instance operation mainly includes attribute operation, determining whether to specify an instance of an entity and whether an instance is equivalent.
4. Environment operations: mainly include session, repository, model and other operations. These operations establish or modify the running environment of SDAI.

The early binding library is implemented by C + + files generated by express mode processor. The feature of early binding library is that it can directly operate the data without querying the data dictionary, so it has high operation efficiency. In addition to some type definitions, class definitions are subclasses of application instance class (Applicationinstance); the aggregation types are subclasses of table, array, set and package respectively; Select a subclass of type select. The language binding first defined in SDAI text is the late binding of C language, which provides instructions in the form of function library. Because of SDAI, users only need to pay attention to the accessed data and do not have to care about the access mechanism. Any data following the step standard can be accessed through SDAI [42]. Therefore, for the information exchange, sharing and integration of CAD system, SDAI is applicable in both neutral file mode and database mode. The information exchange mechanism of the system is realized by using the language binding library, as shown in Figure 6.

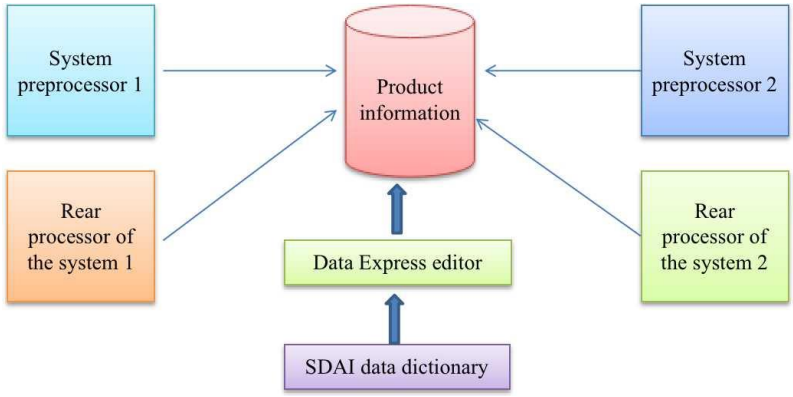

Figure 6: SDAI implementation method.

5 DISCUSSION

5.1 Application of CAD data

5.1.1 Implementation of database

Compared with the implementation method of neutral file, the data sharing and exchange method of CAD system using data database is more flexible and efficient. Although the step standard of database implementation has not been officially launched, some informal database implementations based on the existing step standards have achieved a lot of research results. It is generally accepted that a step to support a database management system should at least have the function of supporting express mode, supporting 6sdab, and meeting step standards. In addition, the database management department needs to implement a step-by-step database integration method. EDBMS is a database management system developed independently of the project. The management system includes object management, storage management, transaction processing, query processing, version management, SDAI interface and other modules. DDL from Express mode to EDBMS is provided by the express converter. The compiler checks the content in express mode according to the express text, which includes syntax elements and syntax rules, and then builds a DDL interpretation of the EDBMS through the conversion mechanism. Express Converter

allows you to convert data from express mode to dictionary, C and C ++. Access to the EDBM of each CAD system is provided through an integrated database access interface via the SDAI function.

5.1.2 Application of implementation method

Based on the wide product model of the whole interval of SIEP, the product database can provide complete product data to other application systems supported by schema. The process of creating a product database is the process of implementing an application scheme defined in an express language on a database according to specific conversion rules and implementation methods. The objects, types, and relationships defined in the diagram are converted into a series of tables in the database. This is an important part of creating a product database. In an integrated environment, product information is stored in a database according to a specific format. Each CAD software system allows direct access to the product database, product data, and product information through its interface with the product database. When creating a product integration system database, the author first creates a data dictionary according to PRODUCT_SCHEMA and creates the organization's main table; Second, the assembly and related parts are developed in MDT according to the functional requirements; Then use the API function provided by MDT to extract the enterprise information; Then open the table of relevant units in the database and determine whether to include the information in the database, depending on whether the entity has the information. Many research outcomes have been accomplished by certain informal database systems based on current step standards. A step-by-step database integration approach must be implemented by the database management department. EDBMS is a database management system that was created separately from the project. Object management, storage management, transaction processing, query processing, version management, SDAI interface, and other modules are all part of the management system. Product information is maintained in a database in an integrated environment using a specified format. Through its interaction with the product database, each CAD software system provides direct access to the product database, product data, and product information. The creation of a product database is the process of implementing an express language application strategy on a database using specified conversion rules and implementation methodologies.

6 CONCLUSION

This article explores the mechanical engineering database's information model, examines the important components of C/S architecture, and introduces SQL and sever2000's good performance. Its goal is to elaborate on the construction of a mechanical intelligent engineering database system based on CAD structure of C/S architecture with SQL and sever2000, which can provide network users with easy tools for sharing and exchanging information. The 7-layer C/S structure is used in practice. A workstation-based client layer, a server-based middle layer, and a host-based data layer make up the three-tier C/S structure. The client does not create database query commands in a 7-tier structure. It communicates with the server's middle layer, which creates database query commands. In the future, we propose to develop an operational environment for facilities managers that combine 3D parametric building modeling with geographic information systems, both of which are linked to a shared database, and investigates the potential benefits and costs of employing this integrated system.

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