THE DEVELOPMENT OF A MATERIALS DATABASE IN CHINA

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ABSTRACT

As carriers and circulators of information, materials databases have been more and more extensively applied in the production of, scientific research on, and circulation and application of modern materials. In this paper, the history of materials databases is presented, the present status of domestic materials databases is discussed, and the development trends of Internet use, standardization, intelligence, and commercialization of materials databases are also discussed.

Keywords: Materials, Database, Materials development, Materials database

1 INTRODUCTION

As a foundation for improving human production and living standards, materials are an important pillar of human civilization and progress. The development, production, circulation, and application of materials relate not only to the flow of material hut also to the flow of information. As carriers and circulators of information, materials databases have been more and more extensive applied in the production of, scientific research on, and circulation and application of modern materials, while database technology has become an important branch of materials science. Therefore, developed countries have attached great importance to the development and application of materials databases, and since the 1970's, China's materials databases have been gradually developed.

2 CLASSIFICATION OF A MATERIALS DATABASE

There are three types of materials databases: numerical, literature, and a combination of the two, which use different forms of data storage and provide access via off-line, package local area networks or the Internet according to the data serving mode (see Figure 1).

There were many numerical databases in the past that used a local area network or offline transmission medium, such as CDs, tapes, diskettes, manuals, and so on (Zhang & Xie, 1997). Off-line materials database systems, because of their low costs and ability to be used with PCs, once occupied a vast market. For example, the "Cambridge Material Selection System CMC" sold by Granta and "Mat. DB" sold by ASM International were very popular material selection systems in the 1980s and 1990s (Price, 1993). New materials databases, which are always of the literature combination type, and database services are usually online, using local area networks or the Internet. The contents consist of literature, experimental data, standards, business information, and other data for CAD/CAE. At present, the more well-known business and professional network materials database include the MatWeb database in the United States and the NIMS database in Japan.

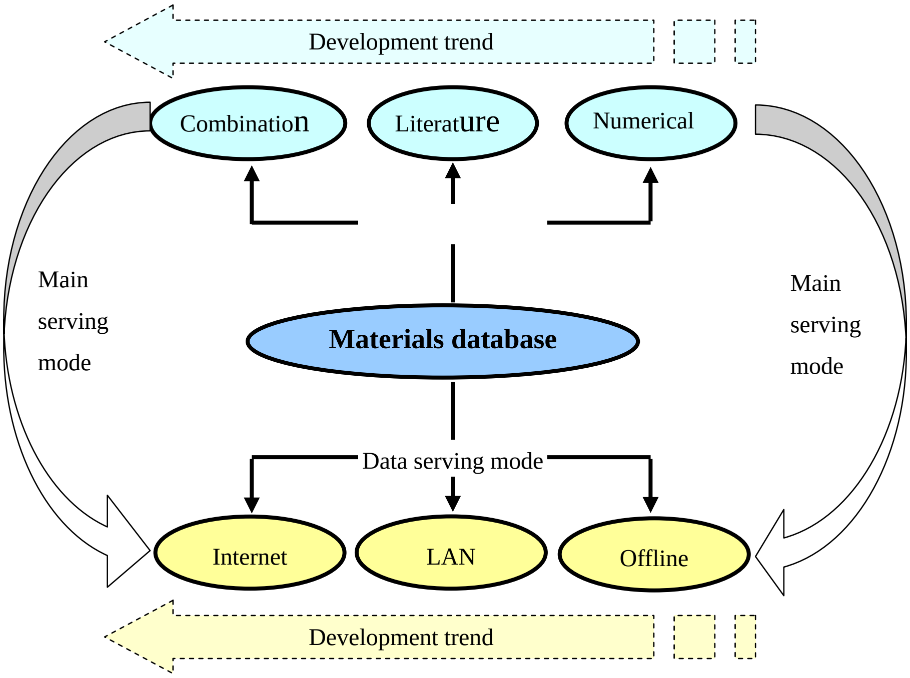

Figure 1. Classification of a materials database

3 PRESENT STATUS OF DOMESTIC MATERIALS DATABASES

The introduction of database technology in China can be traced back to the mid-1970s. The first national academic conference for databases was held in November 1977 and played a major role in promoting the research and application of database technology in China (Yang &Yang, 2004). In 1979, the Institute of Process Engineering and the Shanghai Institute of Organic Chemistry jointly established a chemistry database. It contained more than 10 sub-databases, in which materials data was an important part (Fan, Kong, & Sun, 2000). This is a pioneering work in China's materials database development. The development of a materials database in 1986 was a milestone for China, as this was the first time a Chinese delegation attended an annual meeting of CODATA (the 10th annual meeting). In October of the same year, the first national materials database meeting was held in Beijing, and a material data group was formed under the leadership of the Chinese national committee for CODATA (Yang &Yang, 2004). In the same year, the State Planning Commission approved the "scientific databases and information systems" project, and scientific database building was included formally as a major project in the "the Seventh Five-Year Plan" and the "the Eighth Five-Year Plan." The subject of databases was also extended from chemistry to biology, astronomy, corrosion, energy, and natural resources. This has greatly promoted the development of materials databases in our country. In 1992 and 2006, China hosted the 13th and the 20th CODATA International Conferences.

From the late 1980s, materials databases in China have been developed by research institutes, universities, and factories. The following lists many of these databases (Zhou, 1993; Zhou & Zhang, 1991; Fan et al., 2000).

The Ministry of Aerospace Industry's materials data center and the Beijing Institute of Aviation Material jointly established an aviation materials database and a composite material database of their 863 programs (Zhou & Zhang, 1991). The aviation materials database contains four million data values for 8,000 materials, with the focus of aviation materials. In addition, data on many common materials, special materials, and foreign materials data have also been collected.

The Shanghai Research Institute of Materials and other institutes have established a mechanical engineering materials database. This database has completed a comprehensive test for the performance of 180 steel types and has collected more than 20 million data points, including conventional mechanical properties, physical constants, fatigue, creep, relaxation, anti-oxidation data.. In recent years, the database has been applied in the CAD of tractors, mechanical bearings, internal combustion engines, mechanical loaders, medium and small sized motors, petroleum machinery, lifting devices, and other industrial machinery (Zhou, 1993)

The mechanical strength database established by the Zhengzhou Research Institute of Mechanical Engineering is a distributed database (Zhou & Zhang, 1991).

The Wuhan Research Institute of Material Protection and the Beijing University of Science and Technology have established a corrosion database together.

The rare earth database established by the Changchun Institute of Applied Chemistry of the Chinese Academy of Science has collected physical and chemical properties of rare earth and data of rare earth extraction (Zhou & Zhang, 1991).

In accordance with the requirements of China's high-tech research and development plan in the area of new material, the Material Research Institute of Qinghua University and other institutes jointly established a new materials database that includes five sub-databases: new metals and alloys, fine ceramics, new polymer materials, advanced composite materials, and amorphous materials (Fan et al., 2000).

The General Research Institute for Nonferrous Metals has created a database of nonferrous metals that includes data on 360 kinds of aluminum alloy, of which 162 species are from Russia and 80 are from China. It also contains copper alloys of rare metals (Zhou & Zhang, 1991).

The Center of Iron and Steel Research Institute has developed an alloy steel database that includes a total of 338 steel grades of alloy steel in 8 categories produced in China. This database enables users to choose, in an economic and reasonable way, from numerous steel alloys the type of steel and its performance for their specific needs (http://www.ismcisri.com/cn/data/index.htm).

The Chinese Academy of Sciences has established a science database that is the most comprehensive scientific information service system in China at present. It has the largest amount of information, the widest number of subjects and the highest level of service of all Chinese databases. Until the end of the Ninth Five-Year Plan, it contained 180 databases. A materials database started in 2002 is one of seven initial sub-databases, which also included: a welding materials database, a precision tube database, a titanium alloy database, a material corrosion database, and so on (http://www.csdb.cn/viewdb.jsp?uri=cn.csdb.material).

In order to integrate these scattered databases and make full use of existing data resources to establish a national data-sharing system, in 2004, the Ministry of Science and Technology introduced a "scientific data sharing platform" in the six key fields of the "national science and technology infrastructure platform" plan. This is a plan to build more than 10 scientific data sharing centers and 11 scientific data sharing networks (http://www.most.gov.cn/gjkjjctjptjs/zygz/kxsjgx/index.htm). The application and implementation of this plan will further standardize, commercialize, and provide Internet access for Chinese materials databases.

4 DEVELOPMENT TRENDS OF MATERIALS DATABASES

A materials database is not only a summary of existing knowledge, but it also provides guidance for research and development of new materials and data and standards necessary for production management and quality assurance. Moreover, it can provide users with a basic guide for inquiries about material as well as material manufacturing enterprises. Judging from the international sphere, materials databases have gradually moved toward Internet access, standardization, intelligence and commercialization to improve their usability in materials research, product design, and materials selection.

4.1 The Internet

The development trend to Internet access will unite the dispersed, separate databases into a complete system to provide efficient service to researchers worldwide. Getting these databases on the Internet includes two concepts: making offline databases online and joining online databases into groups.

Although offline numerical databases once occupied a broad market because of their low cost and convenience for use on PCs, with the development of network technology, in particular the rapid development of the Internet and the rapid expansion of the number of Internet users, the Internet has become an important way for people to obtain and disseminate information. More and more offline materials databases are becoming network databases. A representative of this includes a science database established by the Chinese Academy of Science as the "scientific data sharing platform" (Figure 2).

Figure 2. The home page logo of the "scientific data sharing platform"

4.2 Standardization

The standardization of materials databases uses a standardized data interface with material data. These data then serve directly in the development of modern manufacturing and provide data support for technology of various Chinese scientific institution for CAD, CAE, CAM, CIMS, and so on. There are international standards that can be followed for this work, for example, ISO 10303 "Standard for Exchange of Data product–STEP," which provides regulations for the expression and exchange mechanisms of materials data. As long as each application exports the data into the standard data format, it can share these data with other applications (see the chart below) (Rumble & Carpenter, 1992).

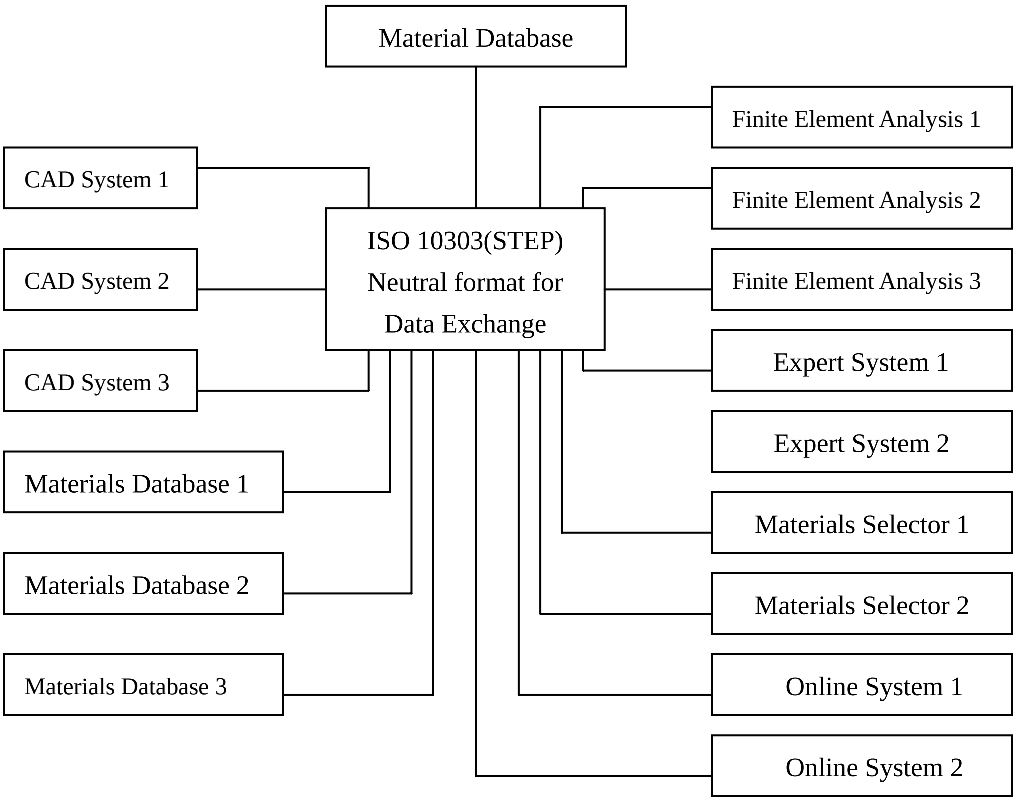

Figure 3. Materials data sharing using standards for data exchange

4.3 Intelligence

The intelligence of materials databases uses computer knowledge discovery, fuzzy inquiry, modeling, and optimization to mine information resources and to enhance the transformation from information to knowledge. The technical approaches include data mining, artificial neural networks, and pattern recognition.

With the development of advanced information technology, the applications offered by databases have far exceeded the original data searches. They can become knowledge bases and combine with artificial intelligence technology to constitute expert systems for material design and performance prediction. This has played an important role in material research, product design, and decision-making. For example, the Shanghai Institute of Microsystems and Information Technology has build an intelligent database used to assistant material design. It is based on a materials database and combines image processing, pattern recognition, artificial neural networks, and design-making optimization. The Center of Iron and Steel Research Institute has made use of pattern matching to develop “multinational material brand matching technology” and has applied this for the exploitation of a “database of Chinese and Japanese steel material brand comparison.”

4.4 Commercialization

The Internet and other technology serve to commercialize materials databases. Such commercialization supports the maintenance, operation, and development of databases through data information services. It is self-evident in the process of the economic development of modern society that the commercialization of materials databases is a tremendous force in promoting their development and industrialization.

Because of China's rapid economic development, strong demand for materials, and large steel industry, a number of steel material websites have come into being in recent years. They include a significant amount of online up-to-date data of steel material such as brands, standards, and information exchange. They provide data services for material users and producers at home and abroad. For example, the website MatGuide (Figure 4), developed through Sino-Japanese cooperation, is a commercial website which serves to give transnational choices in steel materials. This type of website will also become an important branch of modern database development.

Figure 4. The home page logo of the website MatGuide (http://www.matguide.com) developed through Sino-Japanese cooperation

5 CONCLUSION

At present, materials databases continually collect the latest achievements of information science and material science, They have played an important role in engineering design, new materials manufacture, process optimization, physical and chemical testing, and decision-making counseling. It is not difficult to see that materials databases along with modern information technology, such as network technology, knowledge based technology, computer-aided manufacturing technology, and artificial intelligence technology, have opened up a new field of materials science. Moreover, with the advent of the Internet, standardization, intelligence, and commercialization, materials databases will expand and will build a bridge among materials research, production, circulation, and application.

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