Implementing CIMS in Shenyang Blower Works

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Abstract
CIM as a philosophy has received worldwide attention since the 1980s and has been applied to direct enterprise production successfully since then in many industrialized countries. The US government considered the manufacturing industry to be the mainstay of their economy, and consequently gave energetic support to research into manufacturing-related technologies and their development. The European Economic Community and Japan also undertook corresponding R&D programs to support advanced manufacturing technologies to meet the arrival of the twenty-first century.

Not only is the business community making an effort to find an effective management model and technical support structure, but the Chinese government is also beginning to search for an effective means of realizing the transition from a planned economy to a market economy model, especially for large and medium-sized enterprises. To this end, the Chinese government in 1986 drew up a high-technology research and development program in which CIMS featured strongly. Fortunately, SBW was selected as one of the pioneer companies to earn the support of the high-technology research and development program in terms of funds and technology. Consequently more than 80 experts with different academic specialties have been organized to help and direct the enterprise to accomplish its SB-CIMS project.

In the face of the incentives and varied competition in the domestic and foreign market, it is necessary for Shenyang Blower Works to apply CIMS technology in order to enhance the production capacity as a whole, improve their technical skills, shorten the period of delivery, improve the quality, reduce the cost, and increase their manufacturing flexibility (SB-CIMS, 1991). With the variety of SBW’s products, each one is assembled with 1,000-3,000 parts and these parts are very complex and exert strict requirements on accuracy, quality and cost of design and manufacturing. All of these presented difficulties to the product design, production management, and manufacturing, in meeting the customer’s requirements.
Technology Commission, and began in 1990. The Chinese government and SBW invested RMB 2,190,000 and RMB 31,100,000 respectively, and over 80 technical experts from six universities and institutes were organized to develop SB-CIMS. It was just due to the project's ubiquity and important exemplary role for other large and medium-scale state enterprises that the Chinese government attached so great an importance to it.

SB-CIMS, covering the entire production process and product design, consists of three functional subsystems:
1. Production administration and decision information system (PADIS).
2. Engineering design CAD/CAPP/CAM (3C) system.
3. Shop automation (SA) system with distributed quality control.

SBW had begun to apply computers to product design, engineering drawing, and material management since the 1970s. A CAD/CAM system and a production management information system for turbine compressors had been developed, and numerical-control machine tools had been used in the production processes. The applications of advanced technologies had not only brought hope and remarkable economic benefit but also raised a group of qualified technicians in every specialty, especially in computer applications for SBW. It is just because there was not a single CIMS example at that time in China that it was a challenging problem for us to establish a CIM system to support or aid enterprises in reaching their business goals, even though computers had been applied to many aspects in SBW.

The implementation of CIMS

Considering a system engineering principle, a five-step procedure was proposed for implementing SB-CIMS. Each step was developed so that critical ideas within CIM philosophy were reflected.

Step 1: the founding of the SB-CIMS organization

First, a CIMS project headquarters was set up to ensure that SB-CIMS was implemented successfully. The whole organization mechanism is depicted in Figure 1.

The CIMS headquarters is directly led by the general manager of SBW. The CIMS management office is a branch department of SBW responsible for the SB-CIMS project. The general designer office is composed of famous experts from several institutes and universities, which technologically direct the Joint Design Group to accomplish tasks such as the network and database (DB-NET) system, production administration and decision information system, CAD/CAPP/CAM system, shop automation system, and quality control (QC) system.

The joint design group is composed of another 80 experts from six universities and institutes, and 150 staff members from SBW's dozen divisions. SB-CIMS relies on the Shenyang Institute of Automation, at the Chinese Academy of Sciences for technical advice.

Step 2: feasibility study

In the feasibility study phase (SB-CIMS, 1991), the personnel, funds, and technology requirements to implement CIMS are first analyzed, and then evaluated to determine the feasibility of its implementation. The economic and social benefits from implementing CIMS are also considered here in detail.

Compared with foreign advanced enterprises, Shenyang Blower Works still has a long way to go to improve product quality and delivery time and design ability. After the feasibility study for SB-CIMS, the following conclusions were reached:

- The goals of SB-CIMS were in accordance with the enterprise's business objectives.
- Development of SB-CIMS would be beneficial to solve problems encountered in the Time of product delivery (T), the Quality of manufacturing (Q), the product Costs (C) and user Service of provision (S).
- The personnel, funds and technology requirements for the implementation could be assured, although there were many difficulties to overcome.

Step 3: primary design

The primary design (SB-CIMS, 1992) aimed to investigate the real requirements for implementing CIMS. Considering the requirement analysis, a reasonable function and structural design for CIMS was imperative. The primary designs were business-oriented in a relatively longer period.

SB-CIMS is composed of PADIS, 3C and SA as its three main subsystems (Table I), covering the main functions of SB-CIMS, except for the automated material handling system (AMHS).

In addition, an overall quality control system is distributed over these three subsystems.

Step 4: detailed design

Detailed design (SB-CIMS, 1993) aims at providing a development document for hardware and software engineers to implement CIMS. The covering of the detailed design is
development, or programming, oriented to streamline the process.

In view of the products’ complicated structure, it was found that an integrated computer-aided management system (PADIS) would play a more important role in improving TQCS. The emphasis in developing PADIS for SB-CIMS was on perfecting function and system integration. This was because many basic functional units had already been completed. CAD software for compressor design had been imported and redeveloped for the enterprise’s needs. It was decided that a new CAPP system and CAM including NC programming were to be developed. The plan to establish AMHS in SB-CIMS was excluded because of the great amount of financial investment required, and because there were no urgent production needs. Thus the focal point of the SA system was to be manufacturing and management information automation at the shopfloor level. Considering the hierarchical structure principle, SA system was divided into three levels: a shop controller, a cellar controller and a workstation controller to deal with their respective affairs.

Step 5: implementing CIMS in steps
CIMS was intended to be an open computer applications system (SB-CIMS, 1994). With the variations of the enterprise’s business scope or management model, the CIMS system needed to be adaptable for different situations. It was impossible to hope that CIMS could accomplish this in one move. Specifically, CIMS would be too complex to complete in a reasonable time, so that it would generally cause the enterprise to lose both patience and faith in CIMS. This is a fundamental principle in the step-by-step implementation of CIMS.

Going through the steps of feasibility study, primary design, detailed design and partial implementation-breakthrough project, a relatively perfect computer support environment for the computer-integrated manufacturing system in Shenyang Blower Works and primary integrated application software systems had been built. This played an important role in gaining some remarkable economic benefits. A lot of valuable experiences in CIMS implementation had been accumulated and a team of experienced technicians had been trained through SB-CIMS. Over 50 manufacturing enterprises are applying CIMS in China today, purely due to SBW and others’ successful implementation of CIMS.

Step 6: providing technical training at different levels
The education and training of all employees are essential to the implementation of CIMS. The training could be classified into three kinds for different trainees, which are:
1. CIM philosophy education for enterprise leaders.
2. Technology development training for engineers.
3. Operator application skills.

The training was carried out in different ways.

Results of the SB-CIMS implementation
The objectives of the SB-CIMS breakthrough project were:
1. to develop a product quotation system for turbine compressors in the CIMS environment;
2. to improve and extend the PADIS system; and
3. to realize the primary integration of 3C and PADIS.

We hoped to gain remarkable benefits through the realization of these three targets. With the implementation and application of the SB-CIMS breakthrough project, a hierarchically structured CIMS has been built with two dimensions in the directions of
application and information. The following application subsystems have been developed or expanded and improved.

**A computer support environment for SB-CIMS**

A computer support environment, suitable for integration of PADIS, CAD/CAPP/CAM and SA, has been built as shown in Figure 2.

The entire systems structure for SB-CIMS is integrated, and based around the command data facility (CDF). This is shown in Figure 3.

So far, the computer support environment for SB-CIMS has been realized, including:

- An optical fiber token-ring network as the main communications network.
- Ethernet in the workshop.
- Interconnection among dissimilar computers and heterogeneous networks.
- A distributed database processing environment.

**Figure 2**

A computer support environment for SB-CIMS

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**Integrated Manufacturing Systems**

10/2 [1999] 89–94
Expansion of the IBM 4381 computer system.

The addition of 97 sets of various computers and external devices, and 75 types of supporting software.

Totally there are more than 320 sets of computers and auxiliary equipment in SBW’s computer network. The DB-NET group is responsible for building the computer support environment and managing data integration.

The production administration and decision information subsystem

The original production management information system has been greatly expanded and updated. The following modules have been developed and added to the subsystem:

- business planning;
- production preparation planning;
- annual production planning;
- resource management;
- contract management;
- production statistics;
- capacity balance;
- key parts tracing.

For more than a year, the entire production process, from management to preparation to computer manufacturing, has enjoyed improved resource utilization.

Engineering design (CAD/CAPP/CAM) subsystem

The primary integration of CAD, CAPP and CAM has been realized, while the CAD/CAM system for DH and MCL serials of products has been greatly expanded. The following modules have been developed and added to this subsystem:

- BOM generation;
- impeller process drawing;
- impeller CAPP.

Thus, the engineering design of the major products (turbine compressors), whose output value is over 60 percent of the general output value of SBW, can be completed by computers. The coverage of CAD applications has now reached:

- DH type compressor – 90 percent;
- auxiliary – 60 percent;
- instrument system – 90 percent;
- MCL type compressor – 70 percent;
- auxiliary – 60 percent;
- instrument system – 80 percent.

The realization of product design and process planning automation can shorten the product design period from six months to three months and increase product design capacity by 100 percent compared to that in 1992.

Product quotation system

This system contains:

- Technical proposal based on user’s inquiry form.
Financial quotation based on product assemblages.
Business quotation based on the market conditions.

The system can generate quotation files in accordance with the American Petroleum Institute (API) standard. The system can also shorten the quotation period from six weeks to two weeks.

**Shop automation subsystem**
In the SA system the shop controller and cell controller (as well as newly developed simulation software at workstation level) have laid a sound technological foundation for further shop automation. In addition, the following systems have been designed or developed according to the overall plan of SB-CIMS:

- comprehensive information code system;
- GT code software for parts;
- framework of a quality control system in accordance with ISO 9000;
- workshop quality control software;
- central monitoring system.

**Benefits of SB-CIMS**
With the implementation of the breakthrough project of SB-CIMS, the business and production processes in SBW, from product quotations, ordering, design, process planning, material purchasing, production preparation, products manufacturing to packing have been integrated closely. A new management mode, which is partly based on central planning and partly on market requirements, has been built and the organization mechanism in SBW has been optimized.

There are also the remarkable economic benefits resulting from the CIMS project:

- In comparison with 1992, the output value and output in 1993 were increased by 57 percent and 54 percent, respectively.
- The output values and output in 1994 were increased by 143 percent and 90 percent respectively.
- The period of product delivery can be shortened from 18 months to 11-12 months.
- The capital occupied by inventory has been reduced by 29 percent.
- The equipment utilization has been increased by 13.9 percent and the labor productivity has been nearly doubled.

**Conclusion**
Some very useful experiences have been gained from SB-CIMS. Their roles in promoting the efficient development of CIMS are summarized briefly in the following:

- Enterprise leader’s attitude is key factor for CIMS project success.
- CIMS general-purpose design is an important technical document.
- Implement CIMS in steps.
- Insist on a benefit-driven strategy.
- Emphasize the integration of system, technology and personnel.

**References**