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Introduction

The automation and control industry can be divided into industrial and building automation and control. Industrial automation is further divided into factory automation and process automation.

Factory automation and control refers to discrete operations which manufacture individual items used mainly within the automotive, packaging and consumer goods industries. Products mainly consist of items such as programmable logic controllers (PLCs), robots, drives and standardised solutions.

Process automation and control refers to the continuous control solutions applied in processes where the main objective is to control the continuous production of products including raw, oil, electricity and paper at preferred levels. Its products consist of process automation systems, distributed control systems (DCSs), control instrumentation and analytical products such as meters.

Building automation and control comprises product lines and application solutions particularly targeted at building industries. Product lines for this market include security and alarm, ventilating, heating, fire protection, gas warning, air conditioning and access control systems.

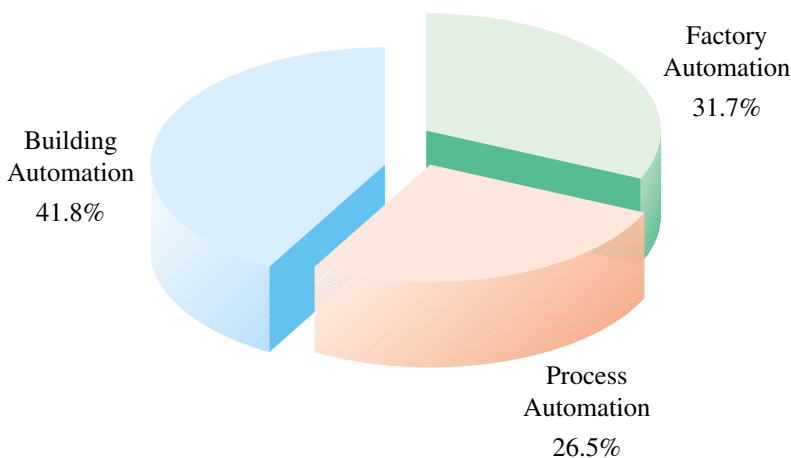
Systems serving today's process automation market requirements are generally based on computer and communication hardware and high reliability needs of industrial automation and control applications. System components are physically distributed throughout a plant or across multiple plant sites, and are linked by high speed digital communication lines to the operation centres. From these centres operators may observe and directly interact with a single control variable, a single unit operation, groups of units, a whole plant-site or multiple plant-sites.

One of the major trends in the automation and control industry is the convergence of factory and process automation so as to widen product offering.

World market

The total revenue in 1999 generated by nine major international automation and control industry enterprises which include General Electric, Siemens, Tyco, ABB, Emerson Electric, Honeywell, Invensys, Schneider and Rockwell Automation was approximately US\$57.3 billion (approximately HK\$447 billion) worldwide which can be broken down as follows:

Worldwide Revenue of Automation and Control Industry (1999)



Source: Company Reports

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The industry is currently dominated by international players such as ABB, Emerson Electric, Honeywell, Invensys and Rockwell Automation. For 1999, Siemens was the market leader for the factory automation and control sector with an annual worldwide revenue of US\$5.1 billion representing 28 per cent. of the worldwide market share of the factory automation and control industry while ABB topped the list for process automation and control with US\$5.8 billion worldwide revenue, representing 38.2 per cent. of the worldwide market share for the process automation and control industry for 1999.

The automation and control industry enjoys robust growth prospects. According to an article from *Electric Age* (電氣時代), the annual growth rate of the industrial automation and control system market (combining factory and process automation) is around 10 to 15 per cent.. Profitability of the US automation and control system providers is usually higher than their European counterparts. For example, Emerson Electric recorded a 16 per cent. operating margin for 1999.

Based on the fact that the average revenue generated from building automation and control for the nine major international automation and control system providers stated above for the year 1999 has surpassed revenue generated from the traditional industrial automation and control industry sector including both factory and process automation, the Directors believe that there will be a rapidly increasing demand for building automation and control worldwide.

The PRC market

History and development

The automation and control industry is a well-established industry in many developed countries boosted by various industrial and communication technologies. However, the automation and control industry is still at an emerging stage in the PRC as it lacks the capital and many of the technologies required for the future development of this industry.

It is the Directors' understanding that due to historical reasons and government policies, the PRC's industrial enterprises possess certain unique characteristics and requirements for automation and control. During the early 1980s, the PRC government decided to promote the development of advance technology in the PRC through importation of technologies from developed countries. It was hoped that through technology importation, domestic industries could understand such technologies and develop new technologies that were best suited to the PRC's own industrial requirements. Accordingly, most of the automation technology and control systems used in state-owned industries such as steel and oil refinery were imported from major foreign automation and control system providers.

Due to the limited access to market information as well as management's limited technical expertise when they made decisions on the types of equipment as well as the suppliers for importing automation and control systems, many of the systems were imported on an ad-hoc basis and could only satisfy the needs of certain stages of the manufacturing processes. In addition, the anti-monopoly policy adopted by the PRC authorities has also prohibited industries from relying on only one or two suppliers for providing complete automation solutions. As a result, the industrial enterprises in the PRC nowadays are facing the following difficulties:

- *Fragmented and incompatible systems prohibiting integration*

The importation of automation and control systems aimed at meeting specific production requirements on an ad-hoc basis has led to fragmented production systems that consist of

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automation and control systems in different models and are sourced from different suppliers. Since most of the major overseas automation and control product manufacturers tend to develop their own proprietary control software for their automation and control systems, such systems are usually closed systems and the connections and standards of which are not compatible with or supported by systems manufactured by other manufacturers. Therefore, when the PRC industrial enterprises face the increasing demand to improve their efficiency by upgrading their production systems, they usually have to replace their entire automation and control systems which means a huge waste of resources. On the other hand, it is more economical to integrate different automation and control systems so as to facilitate a more efficient automated production process.

One apparent example is the development of fieldbus control systems (FCS) which is increasingly used as a communication technology for transmitting signals and data for automation and control systems. Since the automation and control systems produced by different suppliers are “closed systems” which means they have their own communication standards, that causes difficulties to industrial enterprises who want to link up different systems from different suppliers. This becomes a major obstacle for those Chinese industrial enterprises which plan to integrate their existing fragmented automation and control systems and materialise the full benefits of complete automation, such as CIMS in order to achieve automation from the operation level to enterprise management level.

- *Outdated technology and expensive after-sale services of imported products*

Even though many of the automation and control systems are bought from reputable suppliers at a premium price, many products will usually be first introduced in their home countries and by the time they are imported into the PRC, most of them are already obsolete by international standards. For example, most of the IC chips adopted in DCS and PLC systems used by the industrial enterprises in the PRC have limited analytical functions and cannot be used for APC which require large analytical capacity for complex mathematical models and process optimisation.

In addition, since most of the automation and control systems used in the PRC are imported, the costs for requesting support services from the overseas manufacturers such as system upgrade, repair and maintenance becomes prohibitive for PRC entrepreneurs.

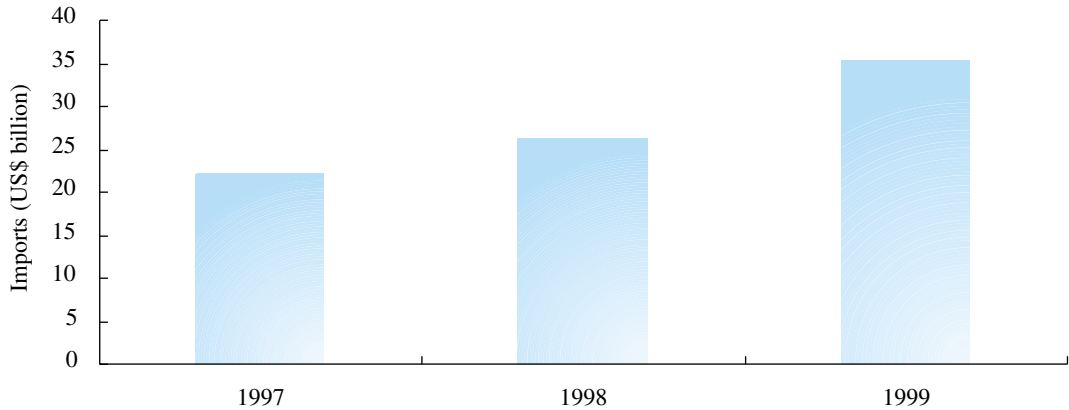
As a result, the Directors believe that there is an urgent need to develop automation and control systems that are best tailored for the unique requirements of industrial enterprises in the PRC in order to solve the difficulties faced by such enterprises.

Market size and future growth

Since the industrial automation and control industry in the PRC is dominated by imports, the level of imports reflects the potential market size in the PRC. According to the PRC's Customs Statistics, the total volume of imports of electrical machinery and equipment, under which automation and control systems are categorised, has been ranked top three in the PRC. The amount surged from approximately US\$22 billion in 1997 to over approximately US\$35 billion in 1999, representing a 60.3 per cent. increase for the period (see Figure 1 below). This shows the huge potential demand for automation and control in the PRC. The United States, being the second largest trading partner with the PRC in 1999, accounted for approximately 49.4 per cent. of the total exports of electrical machinery and equipment into the PRC in 1999.

Figure 1

The PRC's Imports of Electrical Machinery and Equipment



Source: PRC General Administration of Customs, China's Customs Statistics

The average annual exports of automation and control systems to the PRC for the year 1999 from major overseas suppliers including Honeywell, Yokogawa, Elsas Bailey (a member of ABB Asea Brown Boveri), Fisher-Rosemount (a member of Emerson Electric), Foxboro and Siemens, amounted to an average of approximately US\$200 million each. For example, the business volume for Honeywell in the PRC has been growing at a rate of over 20 per cent. in recent years.

While the market for imported automation and control systems is growing substantially, demand for domestically manufactured and integrated automation and control systems is also growing in the PRC. In 1998, the total investment in industrial equipment, machinery and engineering projects by PRC state-owned enterprises alone was approximately RMB390 billion. The PRC's total investments in capital construction and technological renovation in 2000 has been forecasted between RMB320 to RMB400 billion. It is the Directors' understanding that investments in industrial automation and control systems usually account for 15 to 30 per cent. of the total fixed investments by the major state-owned industrial enterprises. On such basis, the minimum total investments in automation and control systems by PRC state-owned industrial enterprises is estimated to be approximately RMB 60 billion for 2000.

The Development Research Center Net (國研網) has also forecasted that the total market size for automation and control products in the PRC will reach approximately RMB 60 billion in 2000. Among the RMB60 billion, the demand for DCS will account for approximately RMB11 billion, PLC approximately RMB24 billion, intelligent instruments approximately RMB4 billion, adaptors and other related automation products approximately RMB10 billion. In addition, the FCS, which is a relatively new industrial communication technology, is also growing rapidly. According to an article from Machinery and Electronics (機械與電子), this sector will reach a market size of approximately RMB100 million in 2000.

As for the building automation and control sector in the PRC, the proportion of investments in building automation and control as compared to total investments in building construction has

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increased from approximately five per cent. in the 1980s to approximately 15 per cent. in 1990s and total investments in building automation and control in the PRC for the year 1999 reached approximately RMB10 billion and it is forecasted that there will be more than one thousand intelligent buildings in the PRC by the 2000.

Growth drivers

Industrial automation and control systems are usually designed for factory manufacturing and process industries. The Directors expect that the market for process automation will grow along with the increase in the level of capital spending by major industries such as oil refinery, power generation and steelworks. The Directors further expect that when the PRC is admitted into the WTO, the lowering of overseas custom duties will follow thus making it more profitable for PRC entrepreneurs to pursue the manufacturing of consumer goods which will in turn increase the demand of automation and control for factory manufacturing industries.

Economic recovery

The PRC's economy is showing signs of recovery boosted by internal and external demands. If the various major industries can benefit from the current economy, then the market for automation will also grow subsequently. Internally, the entry of the PRC into the WTO has sped up its economic restructuring and industrial production. In addition, the opening up of the western provinces of the PRC may also boost the growth of industrial production in the PRC. The total industrial revenue of the PRC from January 2000 to May 2000 has already recorded growth of approximately 11 per cent., representing an increase of approximately two per cent. from last year's figure. Externally, foreign investments for the same period have also recorded a growth of approximately 20 per cent. from last year.

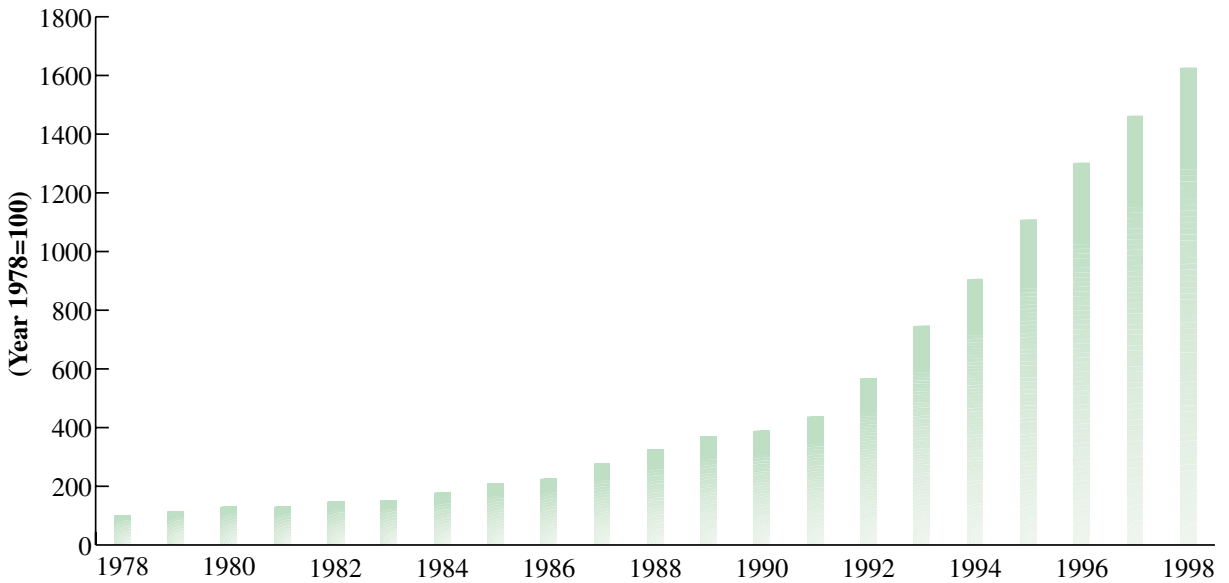
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Capital investments from major industries

Since the end-users of automation and control system products include all major industrial enterprises, the growth of these industries as well as the capital investments made by these industries for improving production efficiency and capacity are crucial to the demand for automation and control products. The industrial sector in the PRC has been enjoying strong growth in the past two decades (see Figure 2).

Figure 2

Growth Rate of PRC Industrial Sector (1978-1998)



Source: China's Industrial Development Report (2000) 中國工業發展報告 (2000)

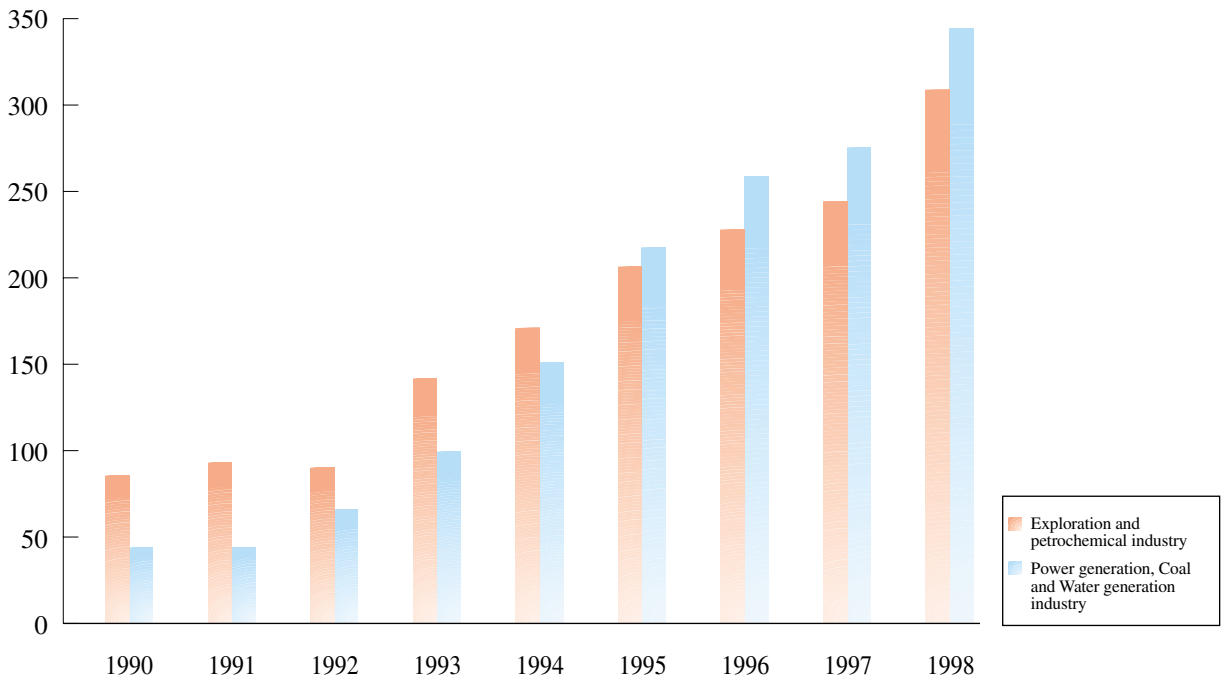
Note: For the base year 1978, the index for the growth rate of the PRC industrial sector was set at 100.

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Specifically, while the automation and control products are most widely used in petrochemical, manufacturing and power generation industries, the capital investment for renovation and improvement made by these industries also exhibited significant growth. The capital renovation and improvement made by exploration and petrochemical industry has increased by seven times from 1985 to 1998 while that for the power generation industry has increased by 19 times for the same period (see Figure 3).

Figure 3

Capital Spending for Renovation and Improvement by Major Industries in the PRC

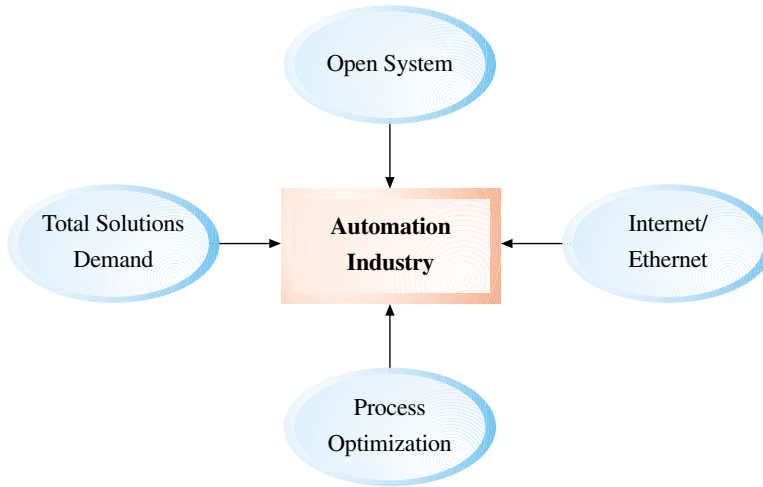


Source: China Statistical Yearbook 1999 中國統計年鑑 1999

In addition, the State Council Research and Development Centre (國務院研究發展中心) has forecasted that the application of automation apparatus, instruments and meters for scientific research, education, agriculture, environmental protection, medication, electrical machinery will amount to approximately 300,000 sets annually while demand for automation and control products for electricity, metallurgy and petrochemical industries will surge to over one million sets in five years.

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Major trends for the automation industry



Demand for Open System

In light of the rapid pace of technological development, customers are seeking open systems with the capacity to be compatible with different types of products and services which comprises a wide range of computer hardware platform and third party software. Open control systems are hubs which link systems for control, instrumentation and supervision of industrial process. An open system not only allows access of information at any point in the enterprise, from the plant level to the enterprise management level, it also means that different instruments and systems can be connected and integrated and resources can be shared. The development of FCS is one step in the trend for open system since FCS allows a common communication standard for data transmission. Building upon an open control system, process optimisation and control of part of the process can be achieved to improve customers' efficiency, quality and safety and cost.

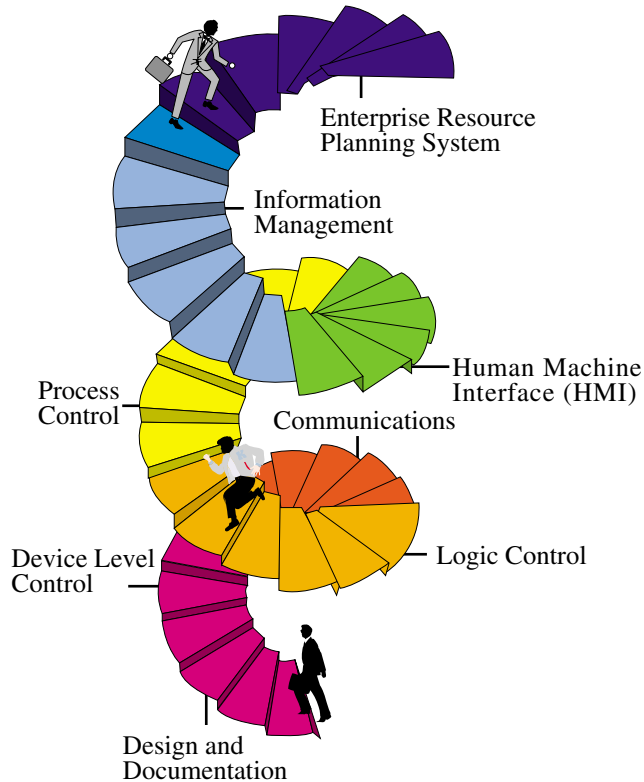
Ethernet and internet Integration

The integration of Ethernet into the automation and control system market is growing rapidly. Since Ethernet uses the common TCP/IP standard for data transmission, FCS which adopts Ethernet as its communication standard will be able to provide an open system for process automation. Ethernet connection offers remote monitoring and diagnostic of plant level operations i.e. supervisors could access information and perform control functions from remote locations. In other words, it renders a low-cost but efficient technology which is spreading into the different aspects of industrial production.

Fully integrated control systems and total solutions

The worldwide reach of customers' operations, and their increasingly pressing demand for fully integrated information systems has increased the need to provide customers with complete automation. According to Frost & Sullivan, a leading technology research corporation, CIMS are growing in importance. CIMS is an integrated system that encompasses all the activities in the production system from the planning and design of a product through the manufacturing system, including control. It is an attempt to combine existing computer technologies in order to manage and control the entire business operations of an enterprise. The Directors believe that the development of open control system which allows seamless connection between different control levels is boosting the growth of CIMS.

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A fully integrated automation and control system from the design stage to enterprise management level.

In addition, there is also a growing demand for total solutions which encompass process control systems, instrumentation devices and advanced software applications that ultimately tie in with applications on resources planning and finance.

Advanced Process Control

Along with the trend for fully integrated control systems, APC is a hot topic for process industries. New constraints that process industries are facing nowadays such as increasing competition, legislation, environment and economic factors have prompted the process industries to ensure the best return on investment, while reducing pollution, improving quality and ensuring personal safety.

APC is a model which simulates complex processes, measures actual performance and controls the process variables for optimal performance. The use of APC in process manufacturing results in less process variability, less unnecessary downtime, fewer replacement parts, and higher yields. It also enables better accuracy in committing customer delivery dates due to more reliable manufacturing.

APC works under complex mathematical models used to optimise both yields and equipment maintenance schedules. The model is based on historical operating data. For example, during runtime operation, the APC software constantly recommends ideal operational set points to operators at the beginning and end of each run, since equipment performance dynamically changes between cleanings. Rather than shutting down equipment on certain time intervals, APC predicts ideal shut down times for maintenance. Since the longer operating intervals create more asset utilisation, the technology of APC helps to maximise production throughput.

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With the increasing popular application of APC in petroleum and refining industry, the Directors believe that APC will become one of the major market trend for the automation industry.

Software capabilities determine the success

ERP is becoming increasingly important to manufacturing industries. ERP is a tall order, building a single software program that attempts to integrate all departments and functions across a company into a single computer system that can serve all those different departments' particular need. The Directors are of the opinion that there is the need to develop software that allows ERP data to be communicated through the automated control system which controls the manufacturing process. Such data will affect the production rate of that particular industry. Such software includes programming software, communications software, data-visualisation software and plant-floor/ERP interface.

Traditionally, the role of automation and control system suppliers was focused on supplying equipment which controlled and automated the physical processes to produce certain products and which is usually purchased as part of an engineered manufacturing or packaging line. However, automation and control system suppliers are nowadays more concerned with software capabilities, its growth as well as the integration of automation systems to ERP systems. Three reasons account for the trend. First, software offers higher growth and margin potential than traditional components. Automation Research Corp. estimates that the worldwide process and discrete automation market will grow by only three to five per cent. over the next two years while the software and service portion of the market will grow by 10 to 12 per cent. over the same period. Second, vendors have to provide applications built on a software architecture that supports the links between plant-level systems and business applications such as ERP. The real advantage of ERP will not be realised without a plant-floor to top-floor solution for sharing plant data. The rapid growth of ERP software market thus represents a significant opportunity for automation vendors whose systems come with state-of-the-art software for implementing ERP. Third, manufacturers are increasingly obsessed with flexibility, time to market, and cycle time. The Directors believe that software that facilitates flexibility and speed will be most favored by customers subject to time-based competition. It is believed that software will be the driving force in customer modernisation decisions, pulling in purchases of platforms and components of a control system.

Market potential

Continuous Production Process industries such as oil refinery, petrochemical, electricity generation and environment protection etc occupy an essential role in mainland China's economy. The rapid economic growth of the PRC represents a significant opportunity for the industrial process automation technology. However, since the automation technology in the PRC still lags behind that of developed countries, the market of automation and control systems is dominated by foreign competitors. On the other hand, there is ample room for growth for the automation and control industry in the PRC and the government is providing strong support to develop the local industry. According to the "Realisation Scheme of Important Specialised Projects on High-Tech Industrialisation of Industrial Process Automation" (工業過程自動化高技術產業化重大專項實施方案), the PRC government intends to put into place a project for the development of the local automation and control industry in order to increase the market share of local manufacturers to at least 50 per cent. The project also aims at developing domestic system, installation, software and instruments markets with RMB20 billion or above sales and a domestic market share of 30 per cent. in three years. Projected sales for the domestic markets will be RMB 40 billion and 50 per cent. market share by the end of the tenth five-year plan of the PRC.