Design of Computer Integrated Manufacturing System for Irankhodro Auto Industry

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Abstract
Computer-integrated manufacturing (CIM), technologies are presented as solutions to manufacturing organizations, which need to perform well in all customer-related dimensions simultaneously. In the literature, CIM technologies providing such benefits as more frequent production changes, reduced inventory level, improved ability of producing complex parts with a high degree of accuracy and repeatability, considerable savings in scrap and rework, lower manufacturing lead-times. In this paper a general model and architecture of CIM for Irankhodro auto industry is designed. Also for each function or subsystem a model is design in CIM environment. The Model has three rings. First ring including three sections: data management, data representation and communication. Second ring is decision support system (DSS) including three sections: DSS for design, DSS for manufacturing and DSS for management. Third ring including all functional area including marketing, design, process planning, manufacturing, production planning and control, quality control, warehouse, management, Finance etc. Also For design of CIM system seven levels is considered including: at business level, at facility level, at shop floor level, at cell level, at workstation level, at machine level, at sensor level. Also CIM model of Iran is based on the seven layers of standard namely open system interconnection (OSI) defined by ISO. IranKhodro auto industry briefly introduce and its barrier and problem for implementation of CIM is discussed. The main objective of this paper is design of a CIM for Irankhodro Automotive Industry in Iran.

Keywords
CIM, Integration, Manufacturing, Irankhodro, Data management, Communication

1. Introduction

Today in order to be competitive in market and to improve products and processes, manufacturing organizations need to utilize proper technologies. Technologies that integrate all functions are including marketing, product design, process plan, manufacturing, management, customers and suppliers. Manufacturing organization should be capable to produce competitive products in characterized as: products with high levels of design, technologically complex and innovative products, reliable, affordable, and Newer, better products; products that solve a variety of society's problems. The evolution of engineering design and manufacturing is based on man's effort to change and improve him self, society and environment. Design, process planning and manufacturing are three related activities that date from the early days of human creation. If people require new goods owing to social conditions, they have to improve existing product, or even invent new products to suit their needs. When more than one person is involved integration, communication and cooperation become necessary. In traditional product development, design is not really separated from process planning and manufacturing phase [1]. Before the industrial revolution, individual craft integrated all aspects of the product development cycle from customer requirements, through design, process planning and manufacturing. Products were developed based on knowledge, skills and work of individual craftsmen. The industrial revolution gave rise to new specialists, who helped to make industries more efficient in design and manufacturing. In recent times, as the market place becomes global and competition between producers increased, manufacturing environment has changed. The product development cycle has become sequential, and the gap between design and manufacturing has widened. Manufacturing cannot start before design is completed and final decisions are documented. In some companies, the design department is located in different building, cities and even countries [2]. Design takes place in different cultures and environment remote from the manufacturing capabilities and constraints. The knowledge of a new product required by designers is now so great that consideration of much information manufacturing constraints which also demand much information becomes very difficult. Manufacturing engineers face the same problem. As a result, integration between design and manufacturing becomes very difficult and product development time and cost are increased and productivity and market share and benefits reduced. Integration of design and manufacturing has not been fully achieved. The increase use of computers and powerful tool such as CAD, CAPP, CAM, Computer numerical control (CNC), FMS, Case base reasoning (CBR), intelligent system (IS) computer hardware and software have reduced the gap between design and manufacturing. All these technology tools aim towards reeducation in product development time and cost, improve quality and increase productivity while satisfying functional requirement. In CIM computers, communication, databases and decision support system are used to integrate various island of automation.

2. Literature review

CIM is the manufacturing approach to integrate all manufacturing functions using computers to control the entire manufacturing organization. CIM relies on closed-loop control processes based on real time input from sensors. This integration approach allows individual manufacturing functions to exchange information with each other and initiate actions. Through the integration of computers, production of product can be improved, faster and less error. The main advantage of CIM is the ability to create automated production processes. According to Kusiak the computer plays an important role integrate the following functional areas in CIM system: Part and product design., tool and fixture design, process planning, Programming of numerically machines and material handling systems, production planning, machining and assembly, maintenance, quality control, inspection, and Storage and retrieval system [3]. In the past in comparison between Japanese and the American and the European manufacturing organizations, the literature shows that; Japanese companies spend 66 % on definition, 24% on design, and 10% on redesign, American companies spend 17% on definition 33% on design and 50% on redesign, European companies spend 17% on definition 33% on design and 50% on redesign [4]. CIM is the manufacturing approach of using computers to control the entire production process [5]. This integration allows individual processes and functions to exchange information with each other and initiate actions. Through the integration of computers, manufacturing can be faster and less error-prone, although the main advantage is the ability to create automated manufacturing processes. CIM is the manufacturing approach of using computers to control the entire production process [6]. CIM technologies are presented as solutions to manufacturing organizations, which need to perform well in all customer-related dimensions simultaneously. In the literature, CIM technologies are frequently viewed as providing such benefits as more frequent production changes, reduced inventory level, improved ability of producing complex parts with a high degree of accuracy and repeatability, considerable savings in scrap and rework, lower manufacturing lead-times, less disruption of production caused by reworks and improved dependability by preventing delivery of incomplete orders to customers [7, 8]. Furthermore, as the demand for different products change, capability to produce a variety of part types brought by the CIM helps the firm to incorporate the changes in demand in a cost-effective manner without causing any disruption in the operation of the plant. In addition, problems in the status of work-flow and machineries can be detected faster, and necessary adjustments are performed in scheduling and resource requirements plans in real time. Cost savings are also achieved through reduced number of indirect personnel and lower overhead costs in the whole organization of the company [8, 9]. Similarly, better utilization of equipments through reduced non-value-adding times lead to the purchase of less number of equipments and lower direct labor cost [10]. Investment in CIM ranges from stand-alone pieces of equipment to fully integrated factories. Investment in CIM can be in design and engineering, manufacturing or administrative functional departments of a manufacturing company. Investments in CIM technologies typically include but not limited to the following 3 categories [11,12] : 1) Stand-alone systems, such as machining centers and computer-aided design (CAD). 2) Intermediate systems, such as automatic storage and retrieval systems (AS/RS). 3) Integrated systems, such as flexible manufacturing cells and systems (FMC/FMS). Although CIM has become increasingly significant and critical in the long-term survivability of manufacturing companies in their markets, limited capital resources, tight credit availabilities and stagnant domestic economies require the manufacturing companies to carefully plan CIM investment decisions. The selected set of CIM alternatives must provide the most improvement in competitive position of a company, and still should satisfy other financial and other objectives and requirements set forward by the management. This integration allows individual processes to exchange information with each other and initiate actions. Through the integration of computers, manufacturing can be faster and less error-prone, although the main advantage is the ability to create automated manufacturing processes. Typically CIM relies on closed-loop control processes, based on real-time input from sensors. Typically CIM relies on closed-loop control processes based on real-time input from sensors. It is also known as flexible design and manufacturing. CIM has been discussed in the literature from different approaches [13- 17]. In the possible terms, CIM is a function of three elements, hardware, software and human knowledge representation. Hardware consists of two elements Computers and Networks. Computers are powerful tool apply to the most effective areas within a manufacturing organization and even outside of organization (i.e. major customers), where they can form part of an integrated manufacturing strategy. Networks are a communication technology, and collection of interconnected autonomous computers. Software: It is clear that without the appropriate software packages the concept of CIM will never become a reality. Without the appropriate software (operating systems AI, Programming Languages Databases etc.) to run the computers then integration can never come to pass. The tool of CAD and computer aided manufacturing (CAM) are being used to great effect, in the effort to increase the efficiency of the engineering design and manufacturing functions. However, this requires further enhancement if the overall effectiveness of the organization is to be achieved .Integrated product development has a key role to play the computer integrated manufacturing system (CIMS) and the extent to which the concurrent engineering principles are applied, will be the major deciding factor of the competitiveness of a nation's industries. However, full implementation of concurrent engineering is still far from reality [14]. CAD and CAM is in fact the heart of integrated product development. It must be considered as the information pump which will serve the central base in which all the engineering and management and other information resides. Many managers and directors as well as manufacturing engineers are frustrated with many different databases created for a single product. They are constantly seeking a single source for all information on the product. This problem might be resolved by using the concept of single database (SDB) that includes all the data from design, analysis, process planning (PP), tooling, quality as well as bill of material (BOM), material requirement planning (MRP), production scheduling and post process information etc [17]. The purpose of this dynamic database is to provide the organization with a single view of engineering, design, manufacturing, research & development, marketing, purchasing, finance, accounting, customer, supplier and management information throughout the life cycle of product development. CAD vendors have created very good geometry tools which when the design is completed, the details are passed on to the manufacturing functions. This however is not enough for integrated product development to succeed. What is required is intelligent, unambiguous product information to all of the engineering functions. The CIM technologies integrate much function and helped to bridge the gap between CAD and CAM. CIM is a system which is able to reduce lead time, and product development time and process , and also reduce overall cost, and increase productivity ,quality , market share, and profit . Integrated product development is an answer to this requirement [18-22]. CIM is the integration of all enterprise factions by using integrated systems and data communication coupled with new managerial philosophies that improve productivity and organizational and personnel efficiency. In CIM all functions are under computer control. This starts with CAD, followed by computer aided process planning (CAPP) and CAM, followed by automated storage and retrieval system (AS/RS). All processes and functions are under computer control [23-26]. More details information and discussion about computer integrated manufacturing and its applications in [27-33].

3. CIM justification

The CIM justification literature emphasizes the importance and necessity of strategic considerations in the CIM selection decisions [34,35] and several fully developed strategic justification models are presented in the literature [36-39]. And Kleindorfer and Partovi [34] mention production lead times, quality, dependability, flexibility and other “intangibles” among strategic considerations. Multi-attribute decision making approaches are often used to evaluate CIM alternatives in terms of strategic considerations [36,39]. Conclusion in the literature, CIM technologies are presented as solutions to manufacturing enterprise, which require to perform well in all dimension including integration of all functions, improved quality, speed, cost, manufacturing control, reduced inventory level, improved ability of producing complex parts with a high degree of accuracy and repeatability, lower manufacturing lead-times, less disruption of production caused by reworks, and all customer-related dimensions concurrently [40,41]. In addition, as market demands change and demand for different type of part and product increase, capability to produce a variety of part and product brought by the CIM helps the manufacturing organization to incorporate the changes in demand in a cost-effective manner without causing any disruption in production. Furthermore, problems in the status of work-flow and machineries can be detected faster, and necessary adjustments are performed in scheduling and resource requirements plans in real time; cost savings are achieved through reduced number of indirect personnel and lower overhead costs in the whole manufacturing organization [41,42]. Also better utilization of equipments through reduced non-value-adding times lead to the purchase of less number of equipments [43]. Investment in CIM ranges from stand-alone pieces of equipment to fully integrated factories. It can be in CAD,CAPP, CAM, CAQC, AS/RS, FMS or administrative functional departments of a manufacturing organization [44,45].

Every manufacturing organization may have its own technical, cultural, structural, and educational problems that are complicated by the varying applications involved. Incompatibility problems among systems and lack of standards for data storage, formatting, and communications. In design of CIM for Irankhodro, these problems should be considered.

4. Iran-Khodro Automobile Industry (IKCO) brief history

Iran-Khodro Industrial Group (IKCO) is the leading Iranian vehicle manufacturer, with headquarters in Tehran. The company's original name was Iran National. IKCO was founded in 1962 and it produced 688,000 passenger cars in 2009. IKCO manufactures vehicles, including Samand, Peugeot and Renault cars, and trucks, minibuses and buses. Iran Khodro was founded by Ahmad Khayami, Aliakbar Khayami, Mahmoud Khayami, marzieh Ahmad Khayami and Zahra Seyedy Dashty, with registered in the capital of 100,000,000 Rls, on August 29 1962 in Ekbatan world in tehran. Iran Khodro Industrial Group is a public joint stock company with the objective of creation and management of factories to manufacture various types of vehicles and parts as well as selling and exporting them. IKCO produces vehicles under 13 brand names. The company has become the largest vehicle manufacturer in the Middle East, Central Asia and North in Iran, it is the largest vehicle manufacturing company [46,47]. In 1997, IKCO broke its own production record by producing 111,111 units of various passenger cars and vans. By 2006 Iran Khodro was producing 550,000 vehicles, and produced 774,965 units of passenger cars and commercial vehicles in 2010. [48]. Iran Khodro, the largest car manufacturer in the Middle East, produced 774,965 units of passenger cars and commercial vehicles in 2010 [48].

5. Factors Effect in Design of CIM for Irankhodro

Design of a CIM consists of individual systems that fulfill the required capabilities, an overall architecture incorporating the systems and the communication links, and a migration path from the current systems architecture. Functional requirements must be compared to the current inventory of systems and available technology to determine system availability. The following techniques are used in satisfying system requirements: 1) exploiting unused and available functional capabilities of current systems; 2)identifying functional capabilities available for, but not installed on, current in-house systems; 3) locating systems that are commercially available but not currently in-house; 4)recognizing state-of-the-art technology that is not immediately commercially available on a system; 5)foreseeing functional capabilities of systems on the technical horizon; and 6) determining whether the requirement is beyond the capabilities of systems on the technical horizon. Managers of IranKhodro must understand that short-term goals must support the long-term goal of implementing a CIM. Top management establishes long-term goals for the company and envisions the general direction of the company. The middle management then creates objectives to achieve this goal. Upper management sees the focus as being very broad, whereas middle management must have a more narrow focus. In deciding to implement a CIM, there are three perspectives that must be considered: a) the conceptual plan: b) the logical plan, and c) the physical plan. The conceptual plan is used to demonstrate a knowledgeable understanding of the elements of CIM and how they are related and managed. Thacker goes on to say that the conceptual plan states that by integrating the elements of a business, a manager will produce results better and faster than those same elements working independently. The logical plan organizes the functional elements and logically demonstrates the relationships and dependencies between the elements. Thacker details that it further shows how to plan and control the business, how to develop and connect an application, communications, and database network. The physical plan contains the actual requirements for setting the CIM system in place. These requirements can include equipment such as hardware, software, and work cells. The plan is a layout of where the computers, work stations, robots, applications, and databases are located in order to optimize their use within the CIM and within the company. In design of CIM for Irankhodro, there are six majors' problems and challenge should be considers:

5.1 Technical problems

Technical problems are first complicated by the varying applications involved. Incompatibility problems are among systems and lack of standards for data storage, formatting, and communications. Iran khodro must have people who are well-trained in the various aspects of CIM. They must be able to understand the applications, technology, and communications and integration requirements of the technology.

5.2 Cultural problems

Cultural problems begin within the division of functional units within Irankhodro such as engineering design, manufacturing engineering, process planning, marketing, finance, operations, information systems, materials control, field service, distribution, quality, and production planning. CIM requires these functional units to act as whole and not separate entities. The planning process represents a significant commitment by Irankhodro implementing it. Although the costs of implementing the environment are substantial, the benefits once the system is in place greatly outweigh the costs. The implementation process should ensure that there is a common goal and a common understanding of the company's objectives and that the priority functions are being accomplished by all areas of the IranKhodro auto industry.

5.3 structure problem

In IranKhodro Company, communication and coordination between different function and department usually takes place in hierarchical ladders, and organizational walls, in this kind of organizations flexibility is very difficult, but in a flatter organizational hierarchy, generally enhances organizational flexibility. So in IranKhodro it is necessary to change the hierarchical structure and to reduce the level of hierarchical structure as less as possible.

5.4 Integration of components from different suppliers

When different machines, such as CNC, conveyors and robots, are using different communications protocols (In the case of AGVs even differing lengths of time for charging the batteries) may cause problems.

5.5 Data integrity

The higher the degree of automation obtains in IranKhodro, the more critical is the integrity of the data used to control the machines. While the CIM system saves on labor of operating the machines, it requires extra human labor in ensuring that there are proper safeguards for the data signals that are used to control the machines.

5.6 Process control

Irankhodro uses computers to *assist* design, process plan and the human operators of the manufacturing facility, but there must always be a competent engineer on hand to handle circumstances which could not be foreseen by the designers of the control software.

6. Seven levels and seven layers of Iran khodro's CIM Model

In IranKodro Corporation, there is a unique set of business processes that is performed to convert row material to finished products including marketing, design engineering, processes planning, production, finance, administration, quality assurance and etc. IranKodro shares the same set of high-level objectives and manufacturing data; including 1) developing strategy, policy, and business and financial plans and directions; 2) design and implementation of CIM which use computer hardware and software and information technology to integrate all enterprise functions and to achieve those objectives and increased productivity, cost-effective and responsiveness throughout the enterprise. CIM accomplishes this by addressing each of the major functional areas of the manufacturing enterprise such as: marketing, design and process engineering, Production, finance, management, quality assurance and etc. Integration of these functions and allocating appropriate resources to them requires the ability to share and exchange information about the many events that occur during the various phases of the business process. All enterprise information systems must be able to communicate and exchange information with each other. And, in addition, they must make systems differences transparent to users. There must also be the means to capture data close to its source, then share this data across functional areas, at contractors and even customers. To meet this need, the CIM environment requires a dynamic network of distributed application solutions and enabling functions. These solutions and enablers may reside on independent system platforms and require data from various sources. Some may be general- purpose platforms, while other may be tailored to specific application and system environments. However, the result should be an environment that encompasses the total information requirements of the enterprise from developing its business plans to shipping its products. When CIM implemented in IranKodro, the benefits can extend far beyond the plant floor and its manufacturing processes. They extend into each of the functional areas of the IranKodro Corporation.

6.1 Seven levels of Iran Khodro's CIM Model

For design of CIM system in Irankhodro, the following level should be considered: 1-At business level: lock at the whole auto manufacturing enterprise and develop a business plan and determine communication goals and analysis performance. 2- At facility level: consider the subsystem and functional area and plan and schedule for design, process plan, production, sale, accounting, and purchasing. 3-At shop floor level: lock at the shop floor and supervise and managing operation and allocate resources and schedule production. 4-At cell level: lock at the cells and coordinate operation of multiple stations and sequence of multiple batches through workstations and material handling equipment. 5-At workstation level: consider workstations and coordinate operation of integrated set of machine and command real time to. 6-At machine level: lock at to control machine real time. 7-At sensor and actuator level: consider control of individual sensors and actuators and processing of sensory information feedback. This is shown in Figure1.

6.2 Seven layers of IranKhodro's CIM Model

Local Area Network (LAN) can be used to link suppliers and all IranKhodro's Companies and customers to Irankhodro Corporation. IranKhodro's computer network architectures are based on the seven layers of standard OSI model, namely the Reference Model of OSI defined by ISO. The model is intended to facilitate writing software that can transport easily since each layer performs a specific communication task, an application program written to interact with an upper layer function does so even when changes are made to lower layers. Thus, layering makes application programs adaptable to various computers with minimum changes. The model has seven layers, as shown in figure 2. The end-user or the application "resides" in the highest layer (7). Data originates at the application layer of sender, passes downwards through each layer to the physical layer, and then "out" on the medium. On arrival at the receiver's physical layer, the data moves up through the layers to reach the receiver at the application layer. Each layer at the sender end usually adds a header, and sometimes a trailer, to frame the data passed to it by the higher layer. At the receiving end, these headers and trailers are moved by the appropriate layers so that the end user receives only the original data. This is shown in Figure 2.

7. Architecture of CIM for Irankhodro

This section describes the main building blocks and architecture of Iran Khodro CIM model. In order to describe the Irankhodro CIM model, we have created a circular factory that incorporates the functional areas. Irankhodro CIM model, in order to be useful, it requires providing open and easy access to application developers and systems integration and information systems and system software developer. The Model has three rings. First ring include data management, data representation and communication. Second ring include decision support system for design and manufacturing. Third ring including all functional area including marketing, design, process planning, manufacturing, production planning and control, quality control, warehouse, management, Finance etc. This is represented by the third ring in Figure 3 and Figure 4. One of the important steps in application of integration is to provide for sharing information between multiple applications. A directory of shared data elements is required to manage information needed by the Irankhodro's business processes. This directory provides a single point of control for capturing and storing Irankhodro's shared data. The requirements for integration in

Irankhodro auto industry are three blocks of communication; data management and presentation each have their own set of technical requirements.

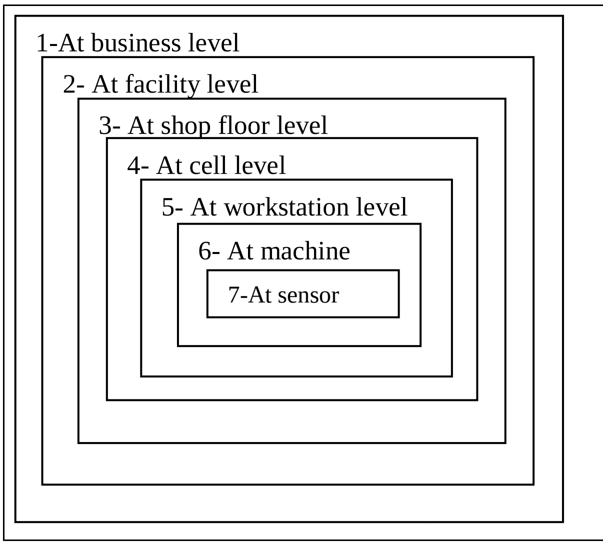


Figure1. Seven level manufacturing hierarchies consider in design of CIM

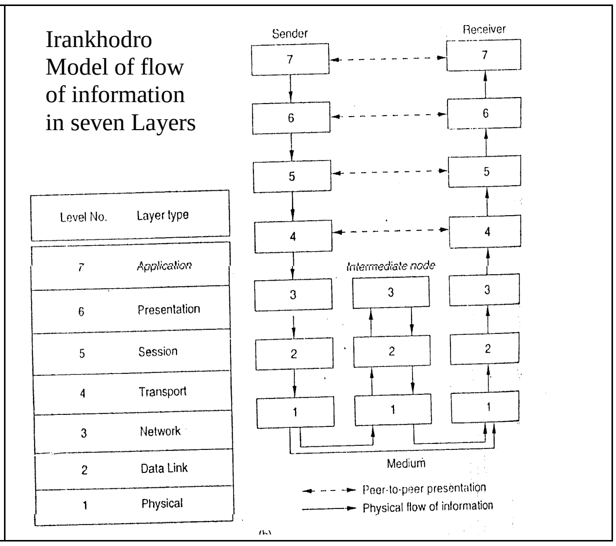


Figure2. Seven layers of flow of information in design of CIM

7.1 Data representation

Data representation in Irankhodro is very critical in today's environment, since there are different functions that required different data with different format. Data management and data representation includes how data is defined, how different data elements are related, where data is stored and who has access to that data. In Irankhodro many functions are used to convert raw material to finished products. In this regard a wide range of devices and information requires producing different types of automobiles. The required information in Irankhodro Corporation must have a consistent way to distribute and present information to different functions and people at computer terminals or workstations, machine, tools, robots, sensors, bar code readers, automated guided vehicles, and part storage and retrieval systems. The range of this information covers everything from simple messages between people to large data arrays for engineering design applications.

7.2 Data Management

One of the important steps in application integration is to provide for sharing information between multiple applications. A directory of shared data elements is required to manage information needed by the IranKhodro's business processes and its suppliers and vendors. This directory provides a single point of control for capturing and storing IranKhodro's shared data. There are so many different data bases, formats, and storage and access techniques in Irankhodro Corporation. Data management in Irankhodro Corporation is very critical in today's environment, since there are so many different data bases, formats, and storage and access techniques in Irankhodro.

7.3 Communications

The important role of communication in CIM is delivering IranKhodro's data to different functions, systems, devices and people. It is an important aspect of CIM model, because industrial environment brings together a wide range of technologies, systems and computer systems. Fig. 5 illustrates how CIM Architecture model of Irankhodro answers the IranKhodro's integration needs and provides a core of common services. These services support all areas of Irankhodro from its common support functions to its highly specialized IranKhodro’s processes.

7.4 Decision supporting systems

Decision support system is the second ring of IranKhodro's CIM model, which supports all functional area and applications. The second ring is shown in Figure 3. This ring support for accessing, summarizing, selecting and analyzing the data required to manage Irankhodro enterprise. The common support functions is divided into following three individual areas:1) administrative support which provides general business or office support such as creating documents, communicating with suppliers, tracking finance, scheduling meeting and etc. 2)decision support which clarifies and presents critical information to decision makers and product designers and manufacturing engineers. 3) Application development support which creates the applications necessary to keep all aspects of the enterprise functioning smoothly and efficiently.

7.5 Integration of all functional areas in Iran Khodro

Third ring represent all functional area of Irankhodro including design, process planning, manufacturing , production planning and control, quality control , warehouse, management, Finance, marketing. This is represented by the third ring in Figure 3. Each function in Figure 4 is equipped with computer and its database. All databases are linked with the main database. In this section we describes the building blocks of CIM model where all functions work closely and communicate interactively in order to convert raw material to finished products. The model is based on current IranKhodro’s organizational chart.

8. Basic component in design of CIM for Irankhodro

Design and architecture of CIM should be so that product development can be done by using communication and computer techniques to integrate all manufacturing functions and activities. These function and activities encompass from market or customer needs, to conceptual design and final product development and delivering to customers and markets. It includes design, process planning, production, quality control, marketing, sales, delivery and after-sales activities. Design of CIM should decrease design costs and reduce overall lead time, and cut work-in-process inventory. Managers of Irankhodro who use CIM should believe that there is a direct relationship between the efficiency of information management and the efficiency and the overall effectiveness of the Irankhodro auto industry. Design and planning of CIM system should provide a description of projects for automating activities, assisting activities with technology, and integrating the information flows among all activities in Irankhodro auto industry. The planning process includes six crucial steps: 1-project activation, 2- business assessment, 3-business modeling, 4- needs analysis, 5-conceptual design and economic analysis. Computer is used to control following functions and stages of new product development In CIM environment: Stage 1-Market requirement or customer needs obtain by marketing team or new technology captured by research and development team. Stage 2-CAD is utilized by product designer to design new product.

Based on market requirement, Stage 3-Rapid prototype technology is used to make physical model and evaluate cost and manufacturability of new product design. Stage 4- Computer aided process planning is used to select material, process, machine and tools and fixture and evaluate cost for manufacturing new product. Stage 5- computer is used for list of material, material and manufacturing requirement planning, capacity and schedule planning. Stage 6-computer aided quality control is used to evaluate quality at each stage of product development. Stage 7-computer aided manufacturing is used to manufacture a new product. Stage 8-computer aided assembly is used to assemble product by robots. Stage 9- Computer is used to sale product and distribution system. Stage 10-Computer is used to manage finance and update accounts. The basic component of CIM for Irankhodro auto industry is shown in Figure 5.

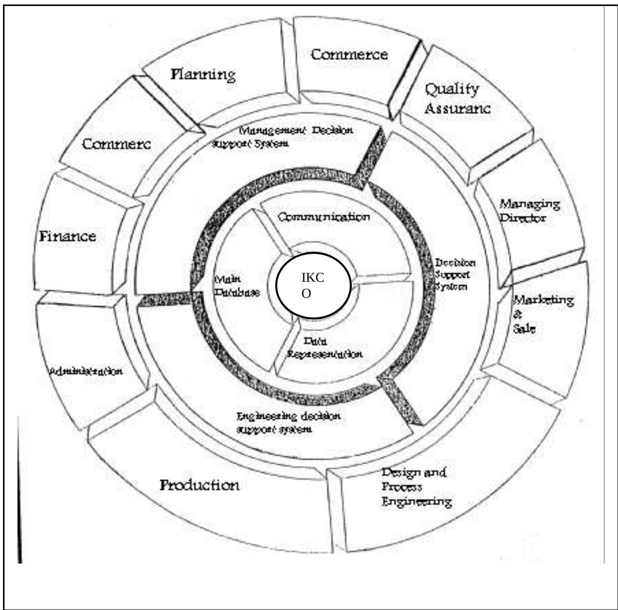


Figure3. Irankhodro enterprise model of CIM and its elements

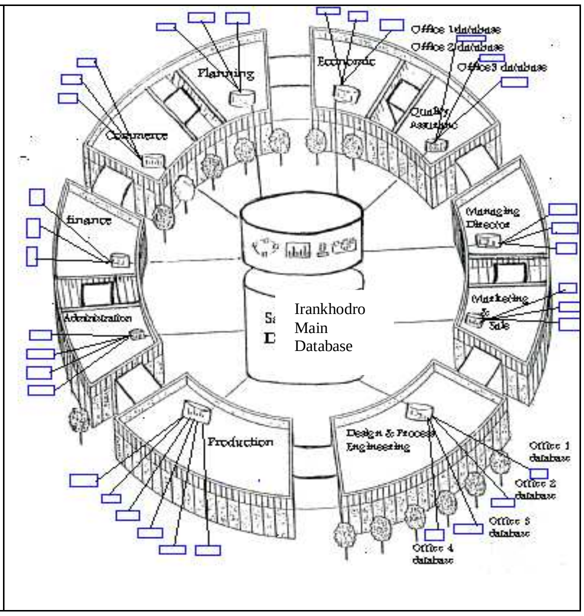


Figure4. Irankhodro functions and main database model

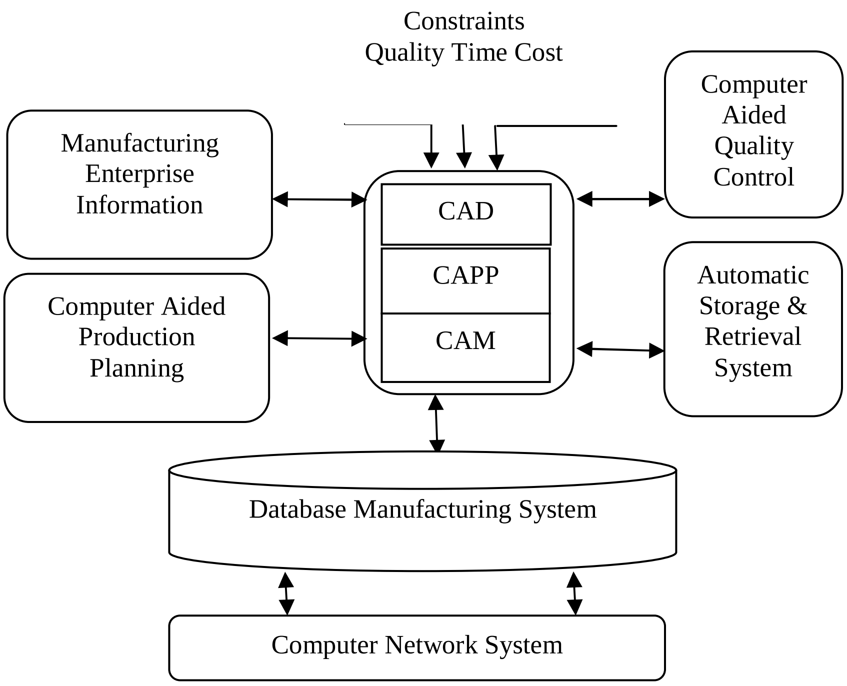


Figure5. The basic component of CIM for Irankhodro auto industry

8.1 Computer Aided Design

There are five phases that are crucial in part and product design. They include translating market requirement to design specifications, conceptual design or preliminary design, refinement, analysis, and implementation and detailed design. At design stage, a product is designed totally on computer. When complete it is tested or its functions simulated on screen before even a prototype is made. If a design of product is involved it is designed by using CAD software and tested on screen. Then product design can be optimized and improved by different computer aided engineering software or expert system and for feed back to designer for selection of optimum design parameter for improve design. The basic component of CAD system is shown in Figure 6.

8.2 Manufacture Prototypes

After product design and testing by CAE software, prototype is manufactured by machines or models are made by rapid prototyping. 3D printers are used to produce an accurate 3D model. CNC machine may used to produce a realistic model. A few prototype product is made and Manufacturability is evaluated. The term rapid prototyping (RP) refers to a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data. The main advantage of the system is that almost any shape can be produced. Time and money savings vary from 50–90 %compared to conventional systems. Rapid prototyping techniques are often referred to solid free-form fabrication; computer automated manufacturing or layered manufacturing. The computer model is sliced into thin layers and the part is fabricated by adding layers on to of each other. Since 1988 more than twenty different rapid prototyping techniques have emerged. A rapid prototyping (RP) technique for physical modeling of a car is demonstrated in Figure 7.

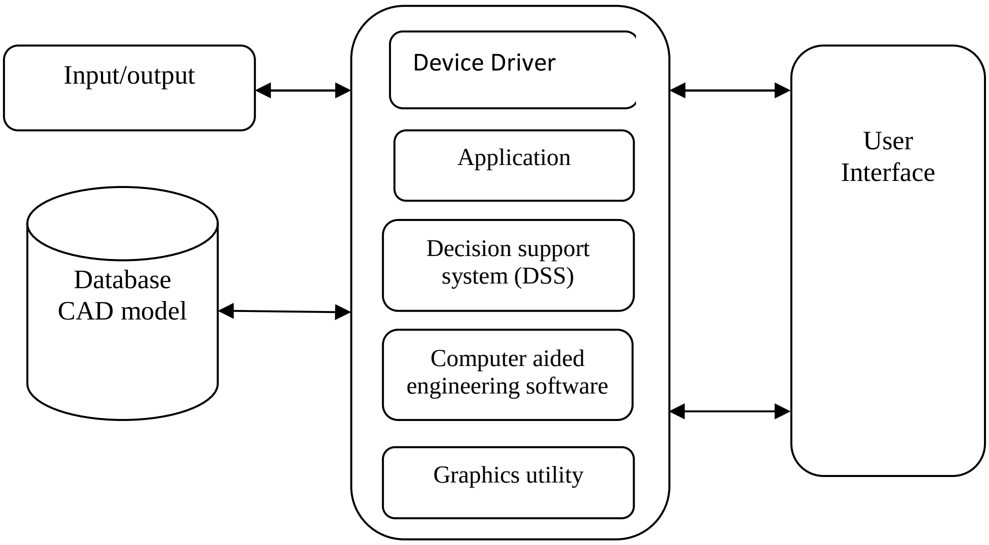


Figure6. The basic component of CAD system

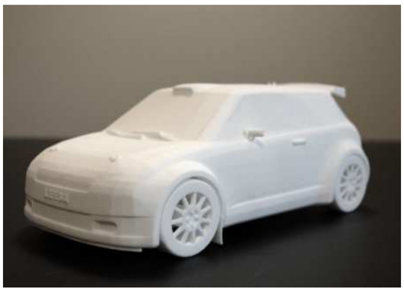


Figure7. A rapid prototyping (RP) technique for physical modeling

8.3 Computer Aided Process Planning (CAPP)

The process planner designs a process plan that outlines the routes, operations, machines, and tools required. Process planers attempt to minimize cost, manufacturing time, and machine idle time while maximizing productivity and quality. At this stage, generative process planning for product designed is generated by using various processes planning software. It selects material size, machine, tools, fixture, dies, production method and calculates machining time and costs. It also evaluates efficiency and productivity. Tooling engineers using computer-aided design (CAD) tools to develop fixtures requirement that is used to produce the parts. Traditional process planning is shown in figure8. Various approaches to computer aided process planning (CAPP) for Irankhodro is categorized in Figure 9.

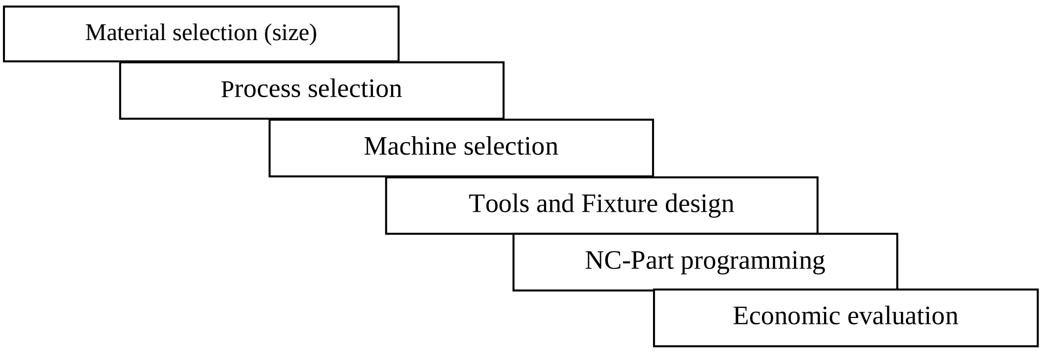


Figure8. Traditional process planning functions

8.4 Computer Aided Production planning &control

There are three concepts used here including materials requirement planning (MRPI), manufacturing required planning (MRPII) and machine loading and scheduling. At this stage, information about number of orders or number of product to be manufactured, and information about storage and distribution are obtained by the computer system. The computer system orders the required materials to manufacture the product. The 'just in time' philosophy is used to order materials / components are needed. Minimum materials are stored to keep the factory going for a few numbers of days. Materials and components are automatically reordered when needed, to keep the factory working smoothly. Computer system controls all functions and subsystem in Irankhodro. This is shown in figure 10.

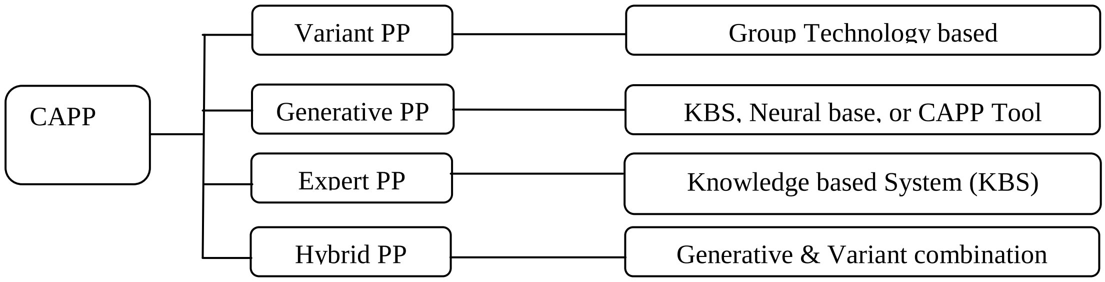


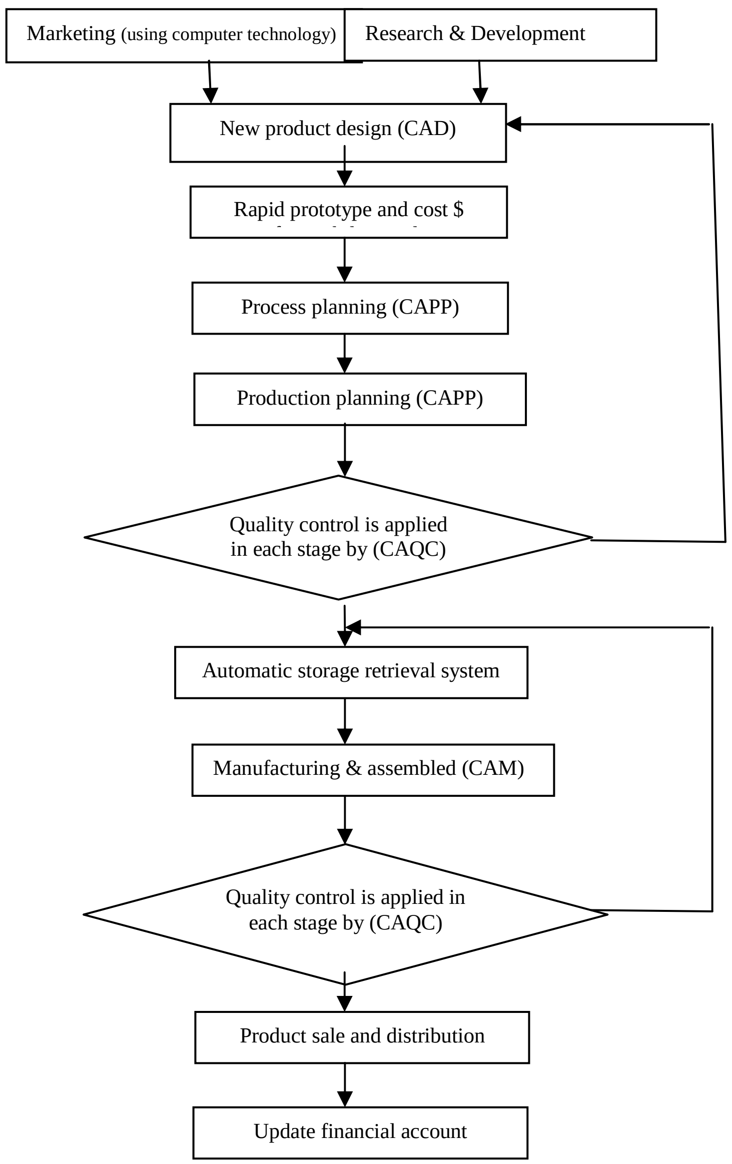
Figure9. Various approaches to CAPP for Irankhodro auto industry

8.5 Quality Assurance, test and inspection

Quality assurance, test and inspection including factions such as: testing items and products to make sure they confirm to specifications is the main activity in quality test and inspection. This includes analyzing and reporting results quickly in order to reduce scrap, rework and recycle costs. Quality test and product specifications are input from engineering. The chief output includes purchased item inspection and product test results to production process and production management, quality test and inspection activity reports to cost accounting, and rejected part and product dispositions to material transfer.

8.6 Computer Aided Manufacturing (CAM)

This is part of the actual manufacturing process, including turning, drilling, and face milling, etc. for metal removal operations. At this stage, according to design and process planning information, product is manufactured by CNC machine, CNC routers and CNC lathes and machining center and etc. Heart of CIM is Integration of CAD, CAPP and CAM. These functions can be integrated by using international standard of exchange of product data STEP and EXPRESS language and interface protocol. There are three methods are used to integrate CAD/CAPP/CAM functions including:1) exchange product data through standard data format such as standard STEP, DXF, IGES; 2)exchange product data through specific defined data format, 3)define unified product data model to exchange product information. Figure11 demonstrates a platform for STEP based CAD/CAPP/CAM integration system.



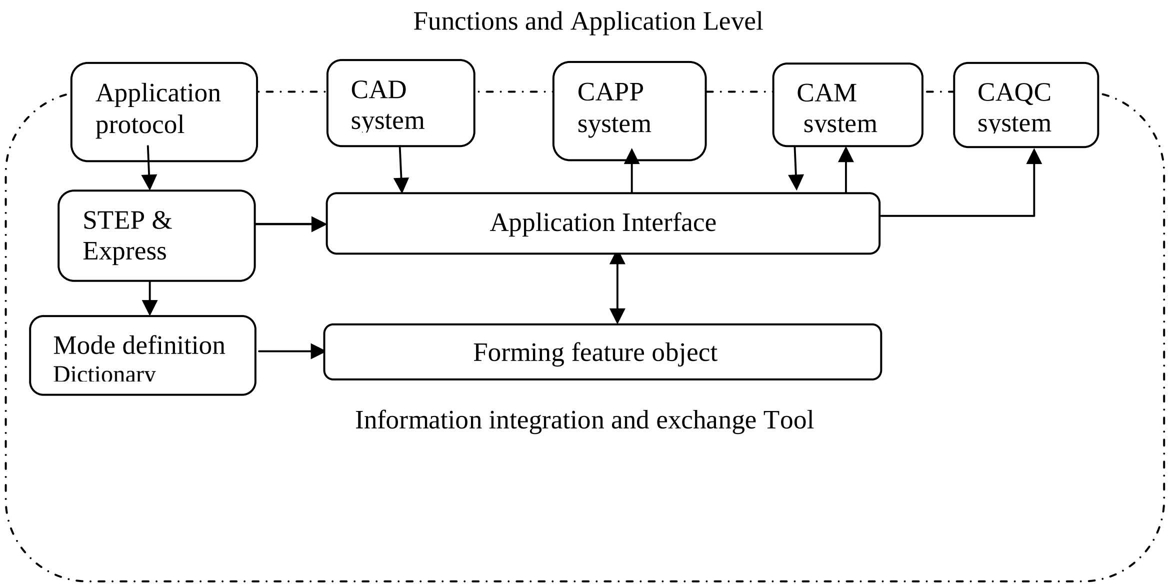


Figure11. A platform for STEP based CAD/CAPP/CAM integration system

8.7 Automated Storage & Retrieval Systems (AS/RS)

The storage equipment described in the preceding section requires a human worker to access the items in storage. The storage system itself is static. Mechanized and automated storage systems are available that reduce or eliminate the amount of human intervention required to operate the system. The level of automation varies. In less-automated systems, a human operator is required in each storage/retrieval transaction. In highly automated systems, loads are entered or retrieved under computer control, with no human participation except to input data to the computer. An automated storage system represents a significant investment, and it often requires a new and different way of doing business. Companies have different reasons for automating the storage function. Automated storage systems divide into two general types: (1) automated storage/retrieval systems and (2) carousel storage systems. An automatic storage/Retrieval System (AS/RS) can be defined as a storage system that performs storage and retrieval operations with speed and accuracy under a defined degree of automation. A wide range of automation is found in commercially available AS/R systems At the most sophisticated level. The operations are totally automated; computer controlled, and fully integrated with factory and/or warehouse operations rat the other extreme, human workers control the equipment and perform the storage/retrieval transactions. Automated storage/retrieval systems life custom designed for each application, although the designs are based on standard modular components available from each respective AS/RS supplier. These two types are shown in Figur12 and Figure 13.

8.8 Computer Aided Quality Control (CAQC)

The use of the computers for quality control of the product is called as the computer aided quality control or CAQC. The two major parts of quality control are inspection and testing, which are traditionally performed manually with the help of gages, measuring devices and the testing apparatus. The two major parts of computer aided quality control are computer aided inspection (CAI) and computer aided testing (CAT). Computer aided inspection (CAI) and CAT are performed by using the latest computer automation and sensor technology. CAI and CAT are the standalone systems and without them the full potential of CAQC cannot be achieved. The main objectives of the CAQC are to improve the quality of the product, increase the productivity in the inspection process and reduce the lead times in manufacturing. The implementation of CAQC in the company results in the major change in the way the process of quality control is carried out in the company. CAQC is applied at every stage of machining. This involves three steps including system design, parameter design, and tolerance and surface finish design. At this stage computer aided quality control is applied at every stage. The product is tested using computer control inspections.

Figure12. showing the (ASRS) underground

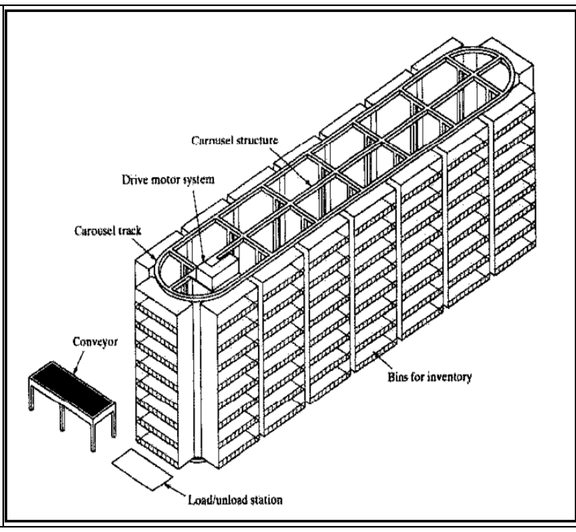


Figure13. carousel storage systems

8.9 Computer Aided Assembly

After parts are manufactured, parts and subassemblies are put together with other parts to create a finished product or subassembly. At this stage the product is assembled by computer system and automated and controlled robots. Data communication to functions, devices and systems in CIM environment is demonstrated in Figure 14.

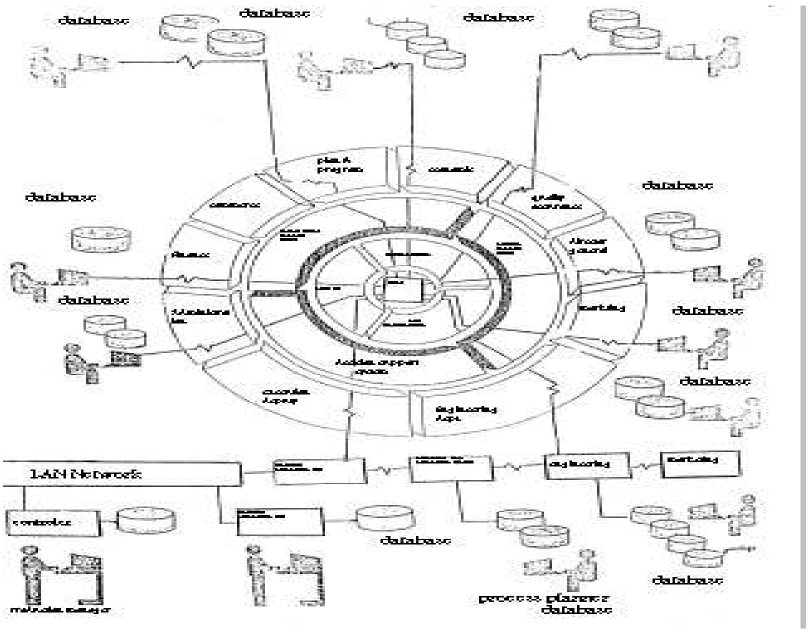


Figure14. data communication to functions, devices and systems in CIM environment

8.10 Computer Aided Sale and Marketing

Computer network is used for product marketing and sale. Information is send directly designers, production planning, and after sale services.

8.11 Computer Aided Financial accounts

Financial account are updated, bills chased up and paid by the computer system. Finance include financial planning and management. In developing financial resource plans, enterprise goals are established. Among the functions are planning costs, budgets, revenues, expenses, cash and investments. Input includes financial goals and objectives established by management as well as summarized financial data received from all areas of the enterprise. The output includes financial reports to stockholders, departmental budgets and general ledger accounting. Data may consist of text and graphics as well as numbers.

8.12 Administration

IranKhodro's services consist of office personnel, management information services, personnel resources and public relations. These services require extensive administrative support tools, such as text processing, decision support and graphics tools. But since input and output will be exchanged throughout the enterprise, it is imperative that these tools are integrated with the enterprise's other systems.

9. Conclusion

In this paper a general model and architecture of CIM for Irankhodro auto industry was designed. For design of CIM system seven level have been considered including: business level, facility level, shop floor level, cell level, workstation level, machine level, and at sensor level. Also CIM model of Irankhodro is based on the seven layers of standard namely open system interconnection (OSI) defined by ISO. The CIM Model has three rings. First ring include data management, data representation and communication. Second ring include decision support system for design and manufacturing. Third ring including all functional area including marketing, design, process planning, manufacturing, production planning and control, quality control, warehouse, management, Finance etc. for each function a model is design in CIM environment. Irankhodro auto industry briefly introduced and its barrier and problem for implementation of CIM has been discussed.

10. Nomenclature and Abbreviation

CIM Computer-Integrated Manufacturing
CIMS Computer Integrated Manufacturing System
CAD Computer Aided Design
CAM Computer Aided Manufacturing
CAE Computer Aided Engineering
CAPP Computer Aided Process Planning
CNC Computer numerical control
CAT Computer Aided Testing
CAI computer aided inspection
MRP Material Requirement Planning
Material Required Planning (MRPI)
Manufacturing Required Planning (MRPII)
BOM Bill of Material

AI Artificial Intelligent
FMC Flexible Manufacturing Cells
FMS Flexible Manufacturing System
OSI Open System Interconnection
AS/RS Automatic Storage and Retrieval Systems

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