Appendix IV

Definitions of the Field of CIM Reference Models

COMPUTER INTEGRATED MANUFACTURING

Computer Integrated Manufacturing is defined in the present context as follows: Computer Integrated Manufacturing (CIM) is manufacturing supported by information and automation intended to create an overall system, (1) which is responsive to the human and economic environment interpreted on all levels and, (2) which improves the management of the industrial facility.

Computer Integrated Manufacturing (CIM) is the use of computers to streamline the flow of materials and information within a manufacturing organization. The goal of CIM is to increase productivity, product quality and manufacturing flexibility while decreasing cost and time-to-market. It's important to keep in mind that CIM itself isn't the goal, but instead a strategy to ensure the long-term survivability of the manufacturing organization.

CIM is the strategy by which manufacturers organize the various hardware and software components, such as robotics, machine vision, CAD, CAM and Manufacturing Resource Planning (MRP-II), into a unified system working toward the same goals. There is, however, no hard and fast scientific formula for CIM.

Each organization must build its own CIM system to fit its personality and organizational requirements. CIM implies more than getting the various pieces of hardware in the manufacturing process communicating with each other. Organizational and procedural flexibility is necessary in the CIM implementation process. Just as a CIM program is molded to the organization, the organization must be willing to change in order to realize the full benefit of a CIM implementation [5].

Computer Integrated Manufacturing involves the development and implementation of a computer-based information management and automation system for the enterprise which allows the establishment of a business process to:

1. Automate the information flow of the plant
2. Deploy appropriate automation and information technologies wherever they are needed in the plant
3. Make optimal use of the capabilities of plant personnel
4. Maximize information access at all levels of the system
5. Provide timely, accurate and complete information on plant operations wherever and whenever needed with the object of obtaining a competitive advantage for the company.

An effective CIM implementation will *improve* the industrial facility's systems':

1. Manageability
2. Product quality
3. Cost effectiveness
4. Accountability
5. Productivity
6. Predictability
7. Flexibility, and
8. Quality of working life of the people involved.

As a result the company is:

1. More responsive to its customers' needs and changing market conditions,
2. Able to improve product quality and lower product costs by:
   a) Improved utilization of resources,
   b) Reduced operational complexity,
   c) Improved ability to respond to disturbances,
   d) Improved predictability/consistency,
3. Able to assist plant personnel in making frequent, routine decisions,
4. Able to improve the availability of timely, accurate and complete plant information,
5. Able to provide better operational tools for improved:
   a) Monitoring,
   b) Control,
   c) Performance,
   d) Costs.

DEFINITIONS OF THE TERMS RELATED TO THE ESTABLISHED MANUFACTURING POLICY

1. The established manufacturing policy is the set of rules (i.e., previously established) for operating the example manufacturing plant to achieve the goals of management. It can be articulated and delegated in a general way (e.g., a set of algorithms rather than required human innovation, etc.). The term policy is understood to extend to individual measurements and tolerances prescribed to implement production.
2. Policy makers are *external influences* that formulate the established manufacturing policy. Because of the innovation necessary, they will be human beings for the foreseeable future.
3. Policy implementors execute the established manufacturing policy. They may be humans, computer systems or other devices depending upon the capabilities needed. Policy implementors comprise the information management and automation system configuration. Policy implementors comprise those [agents whose decisions are effectively computable].

EXPLANATORY NOTE

Because of the current inability of computer systems to innovate in the way commonly attributed to personnel, we cannot expect the planning and policy-making functions of a company to be incorporated into computer systems for the foreseeable future.

Since we are here defining an "automatable" function the above functions must be kept external to the Integrated Information Management and Automation System discussed herein. Thus although they are integral parts of the business enterprise, upper management personnel and their planning function must be considered as external influences driving the computer-based system.

On the other hand, policy implementors (including all proforma decision making) whether machines or people are considered to be integral

parts of the Integrated Information Management and Automation System since their decisions can in principle be expressed in algorithmic form. Whether people or machines are used are economic and political not technological decisions.

IMPLICATION OF THE TERMS RELATED TO THE ESTABLISHED MANUFACTURING POLICY

1. The established manufacturing policy determines the system configuration. If this configuration becomes inadequate (i.e., can no longer be implemented to satisfy the existing policy) because that policy has been changed (beyond allowable limits) then a system redesign (i.e., configuration change) must occur. See Appendix AV.

2. There may be more than one functionally equivalent configuration to implement a particular established manufacturing policy.

3. The major goal of the configuration is to make the plant as controllable as possible within the established manufacturing policy.

4. Conversely, the charge to the policy makers is to define the widest implementable set of manufacturing polices for the plant, i.e., maximum flexibility.

FUNCTIONAL ENTITY

A functional entity is that cohesive collection of elements (humans, machines, computers, control devices, computer programs (any or all)) required to carry out one or more closely related tasks or transformations which comprise a recognized function of the manufacturing plant in fulfilling the established manufacturing policy of the company, e.g., production units or staff departments, etc.

A functional entity may contain other functional entities.

APPLICATION FUNCTIONAL ENTITY

An application functional entity is involved in carrying out the primary mission of the manufacturing plant in question as outlined by the established manufacturing policy of the company. It is directly concerned with the handling and control of raw materials, intermediates and products of the company. The *principles* of *autonomy* and *locality* apply to these entities

Application functional entities serve as sources and/or sinks of process operational data in the problem domain. They are made up of *manufacturing specific functional entities* and the physical means of production or *plant production media.*

FOUNDATION FUNCTIONAL ENTITY

A foundation functional entity is a cohesive collection of elements (possibly shared) that carry out a generic supporting function. It does not necessarily obey the *principles of autonomy* and *locality* in its operations. Examples of foundation functional entities are:

Communications	Man-Machine Interfaces
Control Library	Operating Systems
DataBases	Sensor Management
Graphics Packages	Statistical Quality Control Systems Hardware Etc.

CHARACTERISTICS OF FOUNDATION FUNCTIONAL ENTITIES

Foundation Functional Entities share the following characteristics:

1. Totally shared by all application functional entities or other support functions as needed.

2. Aid in the technical integration of the application functional entities.

3. Problem domain independent.

4. Not a source or sink of process operational data in the problem domain.

5. Are amenable to standardization.

APPLICATION FUNCTIONAL ENTITIES VS. FOUNDATION FUNCTIONAL ENTITIES

APPLICATION FUNCTIONAL ENTITIES

1. Derive context from the problem domain.
2. Cohesive collection of elements performing some recognizable function in the problem (mfg.) domain.
3. Include *manufacturing specific functional entities* and *plant production media.*

FOUNDATION FUNCTIONAL ENTITIES

1. Exist as common support utilities generally applicable to some or all of the application entities.
2. Aid in the technical integration of application entities.
3. Carried out by support elements (specific computers, hardware, and software elements).

MANUFACTURING SPECIFIC FUNCTIONAL ENTITIES

Manufacturing specific functional entities are commonly elements of larger applications functional entities but may be listed as separate entities in their own right. They form the parts of the application functional entities which are included in the plant's integrated information and automation system in contrast to the *plant production media* which carry out the physical production steps and material handling functions of the plant. Manufacturing specific functional entities will commonly include foundation functional entities within their make-up. Examples of manufacturing specific functional entities are:

Computer System Configurations	Product Shipping Administration
Cost Accounting	Product and Process Planning
Inventory Management	Purchasing (Raw Material and Spares)
Maintenance Planning	Quality Control
Order Entry	Resource Management Scheduling

PLANT PRODUCTION MEDIA FUNCTIONAL ENTITIES

Plant production media functional entities comprise those physical production machines, equipments and devices including material handling, which move, position, and transform raw materials into the desired products of the manufacturing enterprise.

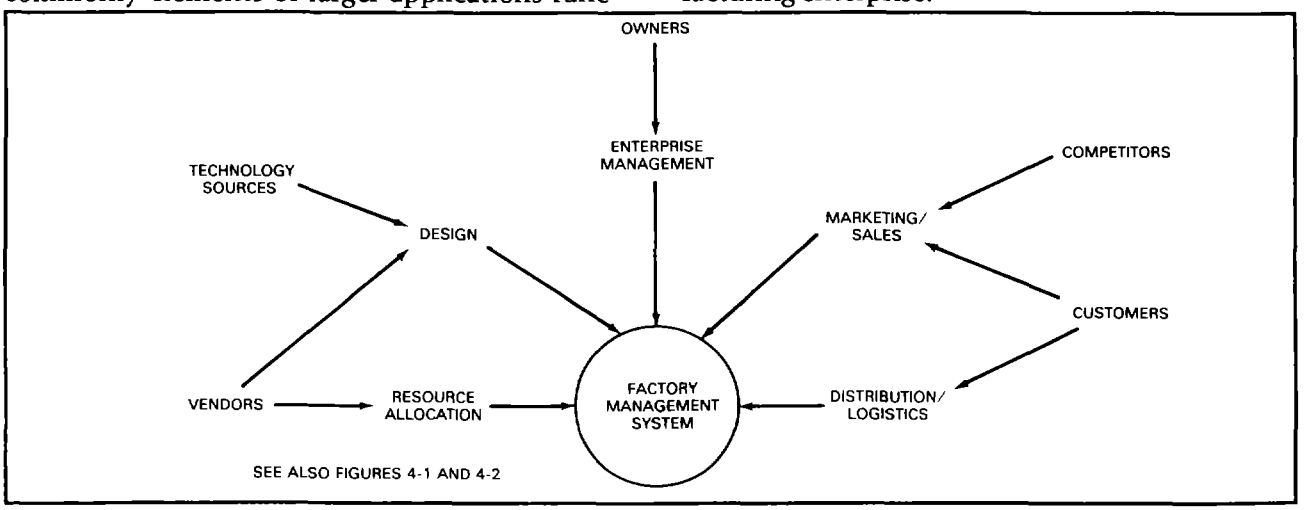


Figure AIV-1 The functional context of external influences.

EXTERNAL INFLUENCES

An external influence is a functional entity (external entity) that is separate from the production plant and does not take part in its internal ongoing operations but whose actions can have an effect upon the future operation of the plant. They may be part of the company in question or may be units of a separate company working with the functional entities of the production plant. See Figures AIV-1 to AIV-4 and Table AIV-I for examples of the various types of functional entities and their interrelationships.

TASKS

A task is a recognized action or set of actions comprising a specific part of the operations of a functional entity of the production plant in fulfilling the established manufacturing policy of the company. It is the lowest level of functional decomposition of an enterprise that corresponds to the function of a single person or machine at a point in time.

A task corresponds to an information transformation in the CIM system.

FUNCTIONAL REQUIREMENT

A functional requirement is a specification constraining the way in which a given task is to be performed, the results to be obtained (speed, accuracy, etc.) as well as the elements of the functional entities involved (initiator, source, receptor, etc.).

CRITERIA FOR CHOICE OF SYSTEM FUNCTIONAL ENTITIES

1. They should provide the most meaningful model (i.e., that lasting through subsequent model development).

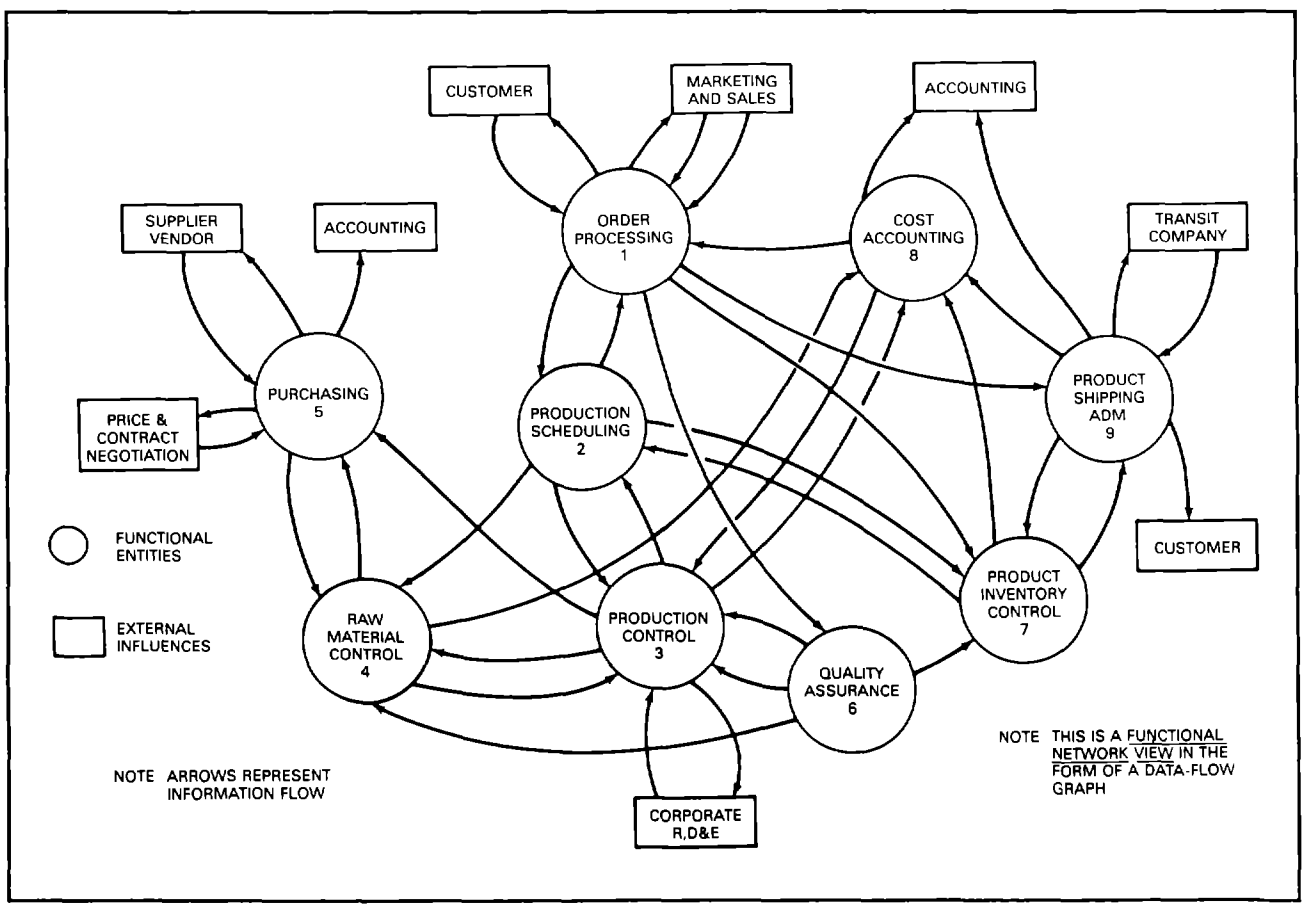


Figure AIV-2 A potential set of manufacturing specific functional entities and external influences for a manufacturing plant.

2. They should provide a distinctive logical node (e.g., an information storage and decision point).
3. All tasks within the functional entity are clearly related.

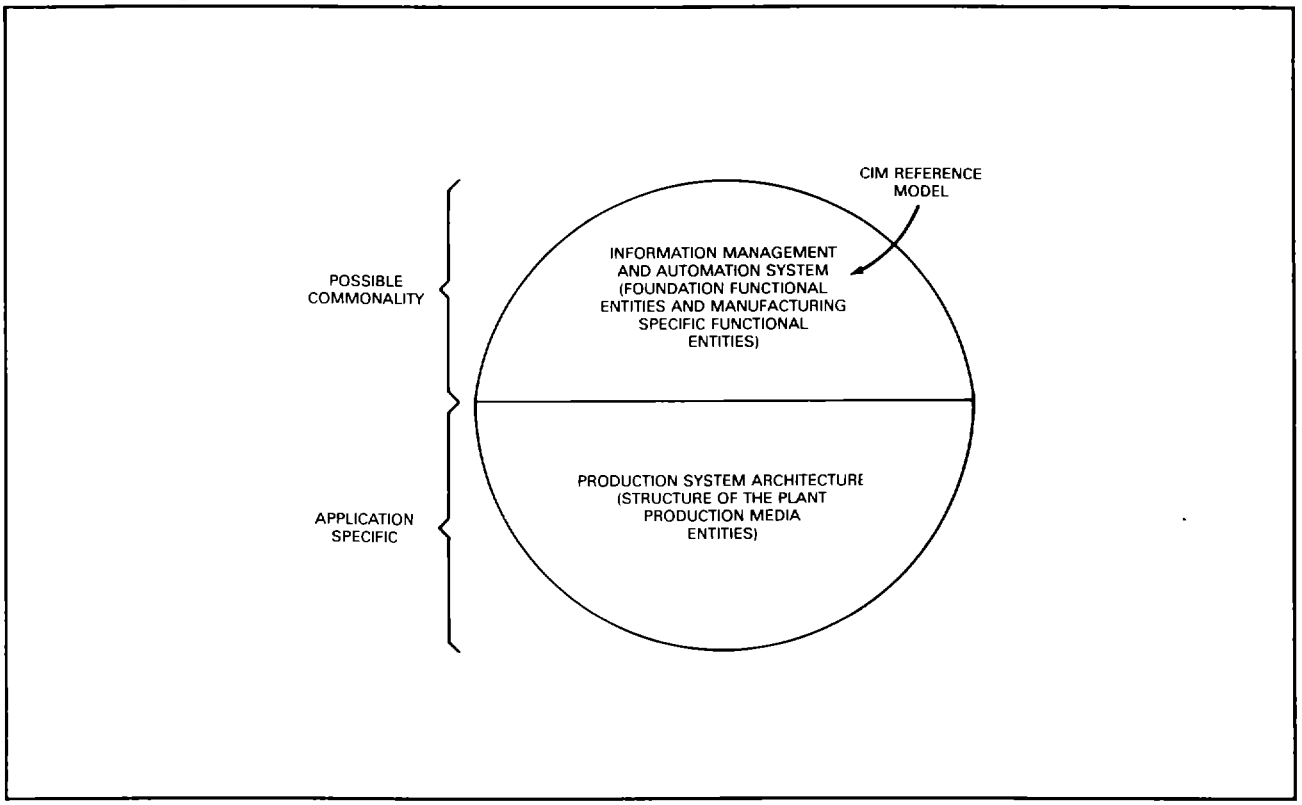


Figure AIV-3 Distinctions between those functional entities exhibiting generic application and commonality versus Plant Production Media entities which are Plant and Application specific.

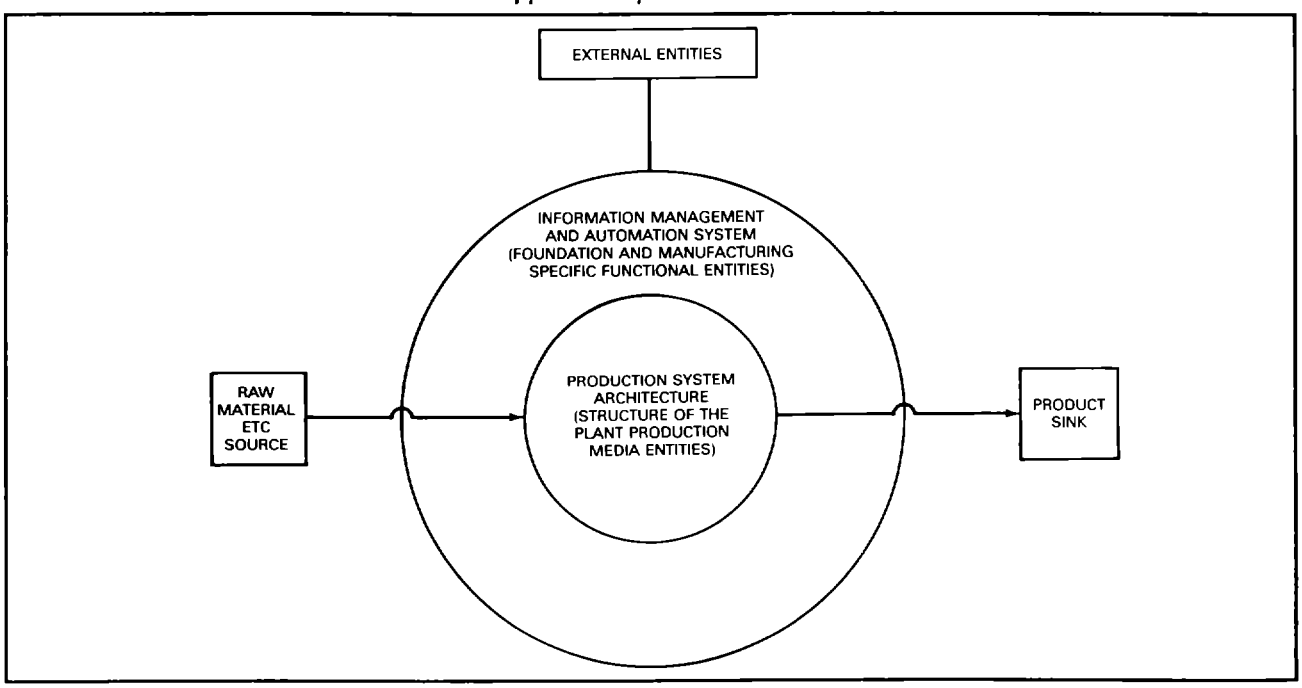
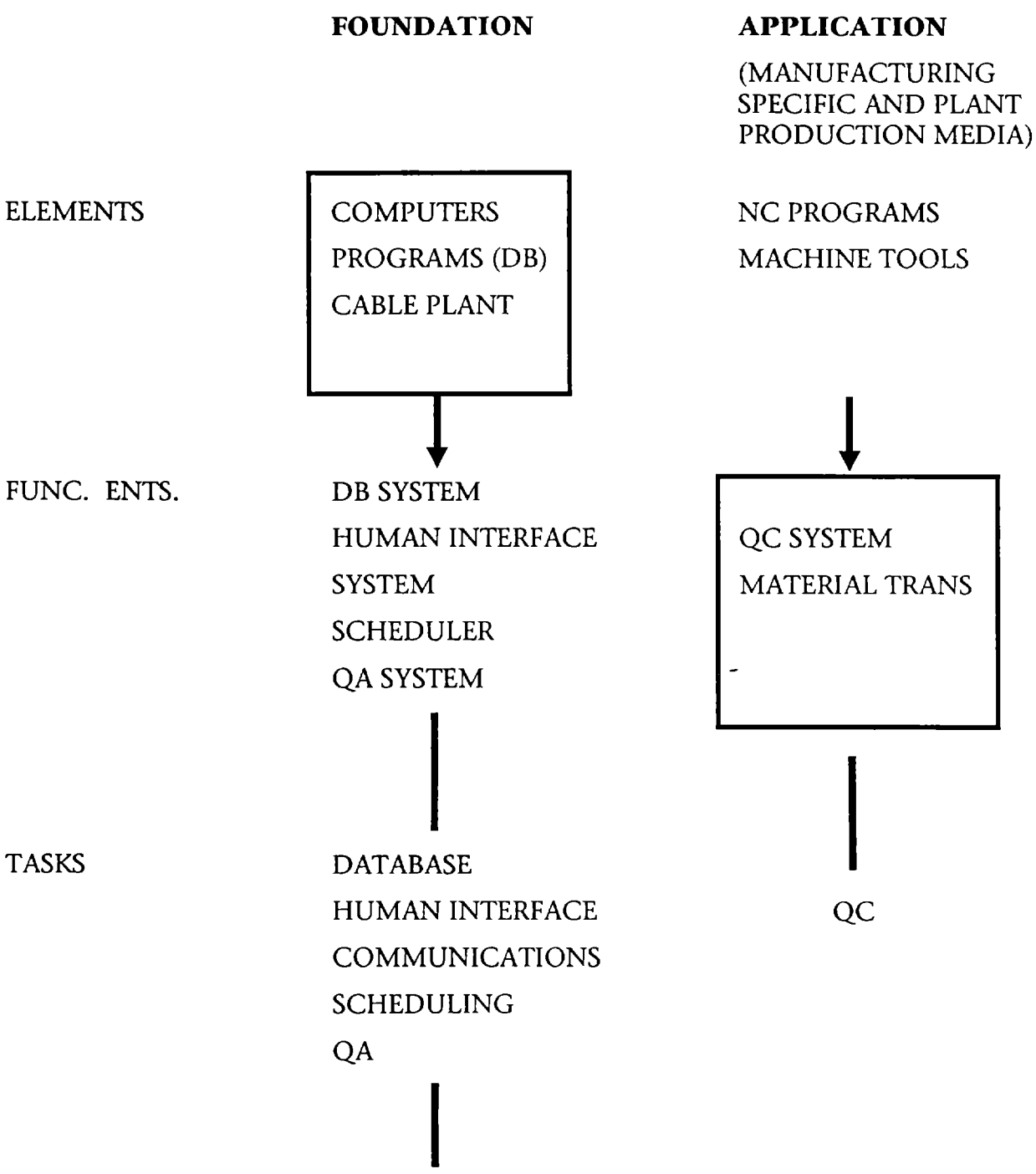


Figure AIV-4 Another diagram showing the relationship of the several classes of entities as regards the CIM Reference Model.

TABLE AIV-1

THE RELATIONSHIP OF FOUNDATION AND APPLICATION ELEMENTS AND FUNCTIONAL ENTITIES IN CARRYING OUT THE TASKS OF THE MANUFACTURING PLANT



A GLOSSARY OF THE FIELD OF CIM REFERENCE MODELS*

ACSE

- Association Control Service Element. ACSE is one of the application protocols specified by MAP

Actual Cost

- An acceptable approximation of the true cost of producing a part, product, or group of parts or products, including all labor and material costs and a reasonable allocation of overhead charges.

Algorithm

- A prescribed set of well defined rules or processes for the solution of a problem in a finite number of steps, e.g , a full statement of an arithmetic procedure for evaluating sin x to a stated precision.

AMIG

- Australian MAP Interest Group (see World Federation).

ANSI

- American National Standards Institute (see Standards Organizations).

Application

- A user or machine oriented function supported by automation technology.

Application Process

- An element within a system that performs the information/data processing for a particular application.

Architectural Resources

- The integrating elements used to build a CIM system. Resources can be categorized as interfaces, protocols or handlers and management tools.

Architecture

- A set of principles, rules and standards and other supporting data, classified and presented in a form to illustrate the arrangement and connectivity of parts of a system.

ASC

- Accredited Standard Committee. A standards committee accredited to ANSI.

ASN.1

- Abstract Syntax Notation One. An ISO standard (DIS 8824 and DIS 8825) that specifies a canonical method of data encoding. This standard is an extension of CCITT standard X.409.

Automated Assembly

- Assembly by means of operations performed automatically by machines. A computer system may monitor the production and quality levels of the assembly operations.

Automation

- The implementation of processes by automatic means; the theory, art or technique of making a process more automatic; the investigation, design, development and application of methods for rendering processes automatic, self-moving or self-controlling; the conversion of a procedure, a process or equipment to automatic operation.

Backbone

- The trunk media of a multimedia LAN separated into sections by bridges, routers, or gateways.

Bandwidth

- The number of user data bytes (i.e., exclusive of communications overhead) that can be sent across the network per second.

Bar Code

- Array of rectangular marks and spaces in a predetermined pattern depicting machine performance; can be numeric, alphanumeric or combinations thereof.

Baseband

- A single channel signaling technique in which the digital signal is encoded and impressed on the physical medium.

Batch Process

- An industrial manufacturing method in which one of several units are produced at a time, in contrast to Continuous Process (q.v.).

Baud

- Unit of signalling speed. Baud is the same as bits per second *only* when every signal event represents exactly one bit.

BER

- Bit Error Rate. The ratio of bits received in error to total bits received.

Bit - 1.

An abbreviation of Binary Digit. 2. A single character is a binary number. 3. A single pulse in a group of pulses. 4. A smallest code element which may possess information in either of two states. 5. An acronym for Binary Digit; the smallest unit of information in the binary numbering system. Represented by the digits 0 and 1. 6. The smallest division of PC word.

Blending

- The process of physically mixing two or more lots of material to produce a homogeneous lot. Blends normally receive new identification and require retesting.

Bottleneck

- A facility, function, department, etc., that impedes production.

Bridge

- A network device that interconnects two local area networks that use the same LLC but may use different MACs. A bridge requires only OSI Level 1 and 2 protocols (Also see *Gateway* and *Router*).

Broadband

- A medium based on CATV technology where multiple simultaneous signals may be frequency division multiplexed.

Broadcast

- A message addressed to all stations connected to a LAN.

Bus

- A broadcast topology where all data stations are connected in parallel to the medium (see Topology).

Business Plan

- A statement of income projections, costs and profits usually accompanied by the budgets and a projected balance sheet as well as a cash flow (source and application of funds) statement. It is usually stated in terms of dollars only. The business plan and the production plan, although frequently stated in different terms, should be in agreement with each other. (*cf*, manufacturing resource planning).

Byte

- A small unit of data bits that are treated as a single unit. The number of bits in a byte is hardware specific, but is most commonly eight (see Octet).

CAM

- Computer Aided Manufacturing.

Capacity

- The highest, sustainable output rate which can be achieved with the current product specifications, product mix, worker effort, plant, and equipment.

Carrier Band

- A single channel signalling technique in which the digital signal is modulated on a carrier and transmitted (also see Baseband).

CASA/SME

- The Computer and Automated Systems Association of the Society of Manufacturing Engineers. CASA/SME is a professional engineering association dedicated to the advancement of engineering technology. CASA/SME sponsors both the MAP and TOP Users Groups.

CASE

- Common *A*pplications *S*ervice *E*lements. CASE is one of the applications protocols specified by MAP. Largely superseded by ACSE (op. cit.).

CATV

- Community Antenna Television (see Broadband).

CBEMA

- Computer and Business Equipment Manufacturers Association (see Standards Organization).

CCITT

- International Consulting Committee on Telephone and Telegraph (see Standards Organizations).

Cell Model

- A graphic representation of a human- or machine-directed function, which has elements of input, activity and output.

Centralization - 1.

The process of consolidating authority and decision making within a single office or person. 2. The act of bringing together physically or geographically operations or organizational units related by nature of function to form a central grouping.

Changeover Time

- The time required to modify or replace an existing facility of workplace, usually including both teardown time for the existing condition and setup for the new condition.

CIM

- Computer Integrated Manufacturing.

CIM Architecture

- A set of principles and rules for selecting and developing products and standards that can participate in a CIM system.

CIM System

- Refers to an implementation of the CIM architecture to integrate an enterprise.

Closed Loop System

- Refers to a feedback control system involving one or more feedback control loops, which combine functions of controlled signals and of commands, in order to keep relationships between the two stable.

CMIG

- Canadian MAP Interest Group (see World Federation).

Cohesion

- Requires that each module is designed to perform a single-well-defined function, and the function is completely contained in the module.

Communication

- The transfer of information and understanding from one point or person to another person. The basic elements in the process of communication are an information source, encoding, transmission, reception, and decoding.

Component

- An inclusive term used to identify a raw material, ingredient, part or subassembly that goes into a higher level assembly, compound or other item. May also include packaging materials for finished items.

Computer

- An electronic device which uses programmed instructions to monitor and control various types of data in order to solve mathematical problems or control industrial applications. Its instructions are executed in various sequences, as required.

Computer Graphics

- A man-oriented system which uses the capabilities of a computer to create, transform, and display pictorial and symbolic data.

Conceptual Model

- An abstract representation of an object or phenomenon that provides a common understanding.

Control

- Measurement of performance or actions and comparison with established standards in order to maintain performance and actions within permissible limits of variance from the standard. May involve taking corrective action to bring performance into line with the plan or standards.

Control Action

- Is the institution of the necessary activity to cause a process, device or system to carry out the tasks assigned to that particular process, device or system.

COS

- Corporation for Open Systems. An organization of vendors formed in 1985 to coordinate member company efforts in the selection of standards and protocols, conformance testing, and the establishment of certification.

Coupling

- Refers to the number of informational and control linkages between two modules. It is desirable to minimize these linkages and make them explicit.

Data

- A representative of facts, concepts, or instructions in a formalized manner suitable for com-

munication, interpretation, or processing by humans or automatic means.

Database Management

- A set of rules about file organization and processing, generally contained in complex software, which controls the definition and access of complex, interrelated files which are shared by numerous application systems.

DCS

- Distributed Control System.

Decision-Making

- The response to a need or stimulus by means of acquiring and organizing information, processing this information to yield alternative courses of action, and selecting one course of action from among the alternatives.

Delivery Schedule

- The required or agreed upon time or rate of delivery of goods or services purchased for a future period.

Direct Digital Control (DDC)

- The use of a digital computer to establish commands to the final control elements of multiple regulatory loops.

Directory Service

- The network management function that provides all addressing information required to access an application process (see PSAP Address).

DIS

- Draft International Standard. The second stage of an ISO STandard (see IS).

Distributed Computing

- Computing performed within a network of distributed computing facilities. The processors for this type of system usually function with control distributed in time and space throughout the network. Associated with the distributed process are distributed storage facilities.

DP

- Draft Proposal. The first stage of an ISO Standard (see IS).

ECSA

- Exchange Carriers Standard Association (see Standards Organizations).

EIA

- Electrical Industries Association (see Standards Organizations).

Electronic Data Processing (EDP) - 1.

Data processing largely performed by electronic devices. 2. Pertaining to data processing equipment that is predominantly electronic, such as an electronic digital computer.

EMUG

- European MAP Users Group (see World Federation).

Enterprise

- Is a set of functions that carry a product through its entire life span from concept through manufacture, distribution, sales and service.

Entity

- An active element within an OSI layer (e.g. Token Bus MAC is an entity in OSI Layer 2).

EPA

- Enhanced Performance Architecture. An extension to MAP that provides for low delay communication between nodes on a single segment (see MAP/EPA and MINI-MAP).

Feedback

- Is the determination of the degree or manner of accomplishment of the control action and the use of the information to assure that the control action is accomplished.

Feedback Control

- A type of system control obtained when a portion of the output signal is operated upon and fed back to the input in order to obtain a desired effect.

Fiber

- See Fiber Optics.

Fiber Optics

- A medium that uses light conducted through glass or plastic fibers for data transmission.

Field Bus

- A standard under development in ISA SP50 for a bus to interconnect process control sensors, actuators, and control devices.

FIPS

- Federal Information Processing Standards (see NBS).

FMS

- Flexible Manufacturing Systems.

FTAM

- File Transfer Access and Management Protocol (ISO DP 8571). FTAM is one of the application protocols specified by MAP and TOP. (DP - Draft Proposal)

Function

- A group of tasks that can be classified as having a common objective within a company.

Gateway

- A network device that interconnects two networks that may have different protocols (see Bridge and Router).

Hardware

- Physical equipment, as opposed to the computer program or method of use; e.g., mechanical, magnetic, electrical or electronic devices. Contrast with software.

Hierarchy

- A data structure consisting of sets and subsets such that every subset of a set is a lower rank than the data of the set. Any structure consisting of units and subunits where the subunits are of lower rank than the units involved.

Human Factors

- The field of effort and body of knowledge devoted to the adaptation and design of equipment for efficient and advantageous use by people considering physiological, psychological and training factors.

Human Interface

- A tool able to intercept, interpret and guide the interaction of the end user with the system.

IEEE

- Institute of Electrical and Electronic Engineers (see Standards Organizations).

IEEE 802

- One of the standards committees working on LAN standards. IEEE 802 has produced standards for CSMA/CD, Token Bus, Token Ring, and Logical Link Control. Activity continues in all of the above areas and in the area of Metropolitan Area Networks. IEEE 802 is composed following WGs (working groups) and TAGs (technical assistance groups):
IEEE 802.0 - Executive Committee
IEEE 802.1 - Higher Layer Interface
IEEE 802.2 - Logical Link Control
IEEE 802.3 - CSMA/CD
IEEE 802.4 - Token Bus
IEEE 802.5 - Token Ring
IEEE 802.6 - Metropolitan Area Network
IEEE 802.7 - Broadband TAG
IEEE 802.8 - Fiber Optics TAG

IEEE P1118

- A standards committee working on the development of a "Microcontroller Serial Control Bus". This standard is to be a technology-based, not application-based and is intended to be suitable for many different application types, including (but not limited to) instrumentation, process control, and RS232-type peripherals.

Information

- The knowledge of facts, measurements and requirements necessary for accomplishing useful work.

In-Process Inventory

- Product in various stages of completion throughout the factory, including raw material that has been released for initial processing and completely processed material awaiting final inspection and acceptance as finished product or shipment to a customer.

Interface

- A shared boundary; e.g., a hardware component to link two devices, a portion of storage or registers accessed by two or more programs.

Integrated System

- A system in which separate programs perform separate functions with communication and data-passing between functional programs performing standardized I/O routines and a common data-

base. Such systems allow flexibility in addition/revision/deletion of various processing functions without disrupting the entire system.

Inventory

- Parts and material on hand.

Inventory Management

- Management of the inventories, with the primary objectives of determining: 1. Items that should be ordered, and in what quantity. 2. The timing of order release and order due dates. 3. Changes in the quantity called for and the rescheduling of orders already planned. Its two broad areas are inventory accounting, which is the administrative aspect, and inventory planning and control, which consists of planning procedures and techniques that lead to inventory order action.

IS

- International Standard. The third (and highest) stage of an ISO Standard. Prospective ISO standards are balloted three times The first stage is as a Draft Proposal (DP). After a Draft Proposal has been in use a period of time (typically 6 months to a year) the standard, frequently with corrections and changes, is re-balloted as Draft International Standard. After the Draft International Standard (DIS) has been in use for a period of time (typically 1 to 2 years) it is re-balloted as an International Standard (IS).

ISA

- Instrument Society of America (see Standards Organizations).

ISA SP50

- A standards committee working on a standard of a communications bus for interconnecting control device to sensors and actuators (Field Bus).

ISA SP72

- A standards committee working on a standards for use in process control. These standards include PROWAY, Process Control Architecture, and Process Messaging.

ISO

- International Standards Organization (see Standards Organizations).

ISDN

- *I*ntegrated *S*ystems *D*igital *N*etwork. ISDN is a suite of protocols being defined by CCITT to provide voice and data services over wide area networks (WANs).

ITI

- *I*ndustrial *T*echnology *I*nstitute. A nonprofit organization founded by the University of Michigan and sponsored by the State of Michigan dedicated to computer integrated manufacturing. ITI offers MAP conformance testing and certification.

JMUG

- Japanese MAP Users Group (see World Federation).

LAN

- Local Area Network. Local area networks are a communications mechanism by which computers and peripherals in a limited geographical area can be connected. They provide a physical channel of moderate to high data rate (1-20 Mbit) which has a consistently low error rate (typically 10^{-9}).

Layer

- A subdivision of the OSI architecture (See OSI Reference Model).

Line Driver

- A circuit specifically designed to transmit digital information over long lines, that is extended distances.

LLC

- *L*ogical *L*ink *C*ontrol. The upper sublayer of the data link layer (Layer 2) used by all types of IEEE 802 LANs. LLC provides a common set of services and interfaces to higher layer protocols. Three types of services are specified:
Type 1: Connectionless. A set of services that permit peer entities to transmit data to each other without the establishment of connections. Type 1 service is used by both MAP and TOP.
Type 2: Connection oriented. A set of services that permit peer entities to establish, use, and terminate connections with each other in order to transmit data.
Type 3: Acknowledged connectionless. A set of services that permit a peer entity to send messages requiring immediate response to another peer entity. This class of services can also be used for polled (master-slave) operation.

LSAP

- Link Service Access Point (see SAP).

MAC

- Media Access Control. The lower sublayer of the Data Link Layer (Layer 2) unique to each type of IEEE 802 Local Area Networks. MAC provides mechanism by which users access (share) the network. The MACs defined by IEEE 802 are IEEE 802.3 CSMA/CD, IEEE 802.4 Token Bus, IEEE 802.5 Token Ring, and IEEE 802.6 Metropolitan Area Network (still under study).

Maintenance

- Any activity intended to eliminate faults or to keep hardware or programs in satisfactory working condition, including tests, measurements, replacements, adjustments and repairs.

Management

- 1. The process of utilizing material and human resources to accomplish designated objectives. It involves the activities of planning, organizing, directing, coordinating and controlling. 2. That group of people who perform the functions described above.

Manufacturing Planning

- The function of setting the limits or levels of manufacturing operations in the future, consideration being given to sales forecasts and the requirements and availability of personnel, machines, materials and finances. The manufacturing plan is usually in fairly broad terms and does not specify in detail each of the individual products to be made but usually specifies the amount of capacity that will be required.

Manufacturing Resource Planning

- A method for the effective planning of all the resources of a manufacturing company. Ideally it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer "what if" questions. It is made up of a variety of functions, each linked together: Business Planning, Production Planning, Master Production Scheduling, Material Requirements Planning, Capacity Requirements Planning and the execution systems for capacity and priority. Outputs from these systems would be integrated with financial reports such as the business plan, purchase commitment report, shipping budget, inventory projections in dollars, etc. Manufacturing resource planning is a direct outgrowth and extension of MRP. Often referred to as MRP II. (*cf*, closed-loop MRP).

MAP

- *M*anufacturing *A*utomation *P*rotocol. A specification for a suite of communications standards for use in manufacturing automation developed under the auspices of the General Motors Corporation. The development of this specification is being taken over by the *MAP/TOP* Users Group under the auspices of *CASA/SME* (The Computer and Automated Systems Association of the Society of Manufacturing Engineers).

MAP/EPA

- Part of the EPA architecture, a MAP/EPA node contains both the MAP protocols and the protocols required for communication to Mini-MAP. It can communicate with both Mini-MAP nodes on the same segment and full MAP nodes anywhere in the network.

MAP/TOP Users Group

- The United States and Canada's MAP/TOP Users Group (see CASA/SME and World Federation).

Market Demand

- The total need for a product or line of product.

Master-Slave

- A mode of operation where one data station (the master) control the network access of one or more data stations (the slaves).

Material

- Any commodity used directly or indirectly in producing a product, e.g., raw materials, component parts, subassemblies, and supplies.

Material Control

- The function of maintaining a constantly available supply of raw materials, purchased parts and supplies that are required for the production of products.

Material Flow

- The progressive movement of material, parts or products toward the completion of a production process between work stations, storage areas, machines, departments and the like.

Materials Planning

- The planning of requirements for components based upon requirements for higher level assemblies. The production schedule is exploded or extended through the use of the bills of

materials and the results are netted against inventory.

Mathematical Model

- A mathematical representation of a process, device, or concept.

Mbit

- Million Bits Per Second.

Media

- The physical interconnection between devices attached to the LAN. Typical LAN media are Twisted Pair, Baseband Coax, Broadband Coax, and Fiber Optics.

Message

- A collection of one or more sentences and/or command statements to be used as an information exchange between applications or users.

MINI-MAP

- A subset of MAP protocols extended to provide higher performance for applications whose communications are limited to a single LAN. A Mini-MAP node contains only the lower two layers Pphysical and Link) of the MAP protocols. It can only communicate directly with MAP/EPA or MINI-MAP nodes on the same segment.

MMFS

- Manufacturing Messaging Format Standard. The application protocol specified by older versions of MAP to do manufacturing messaging. This protocol has been replaced by MMS.

MMS

- Manufacturing Messaging Specification. MMS is one of the application protocols specified by MAP.

Model

- A synthetic abstraction of reality.

Modem

- Modulator -Demodulator. A device that provides both combining (modulation) and separation (demodulation) of data and carrier, and a physical medium interface. Typically used to connect a node to a broadband network (see Transceiver).

Multiplexing

- The time-shared scanning of a number of data lines into a single channel. Only one data line is enabled at any instant.

NBS

- National Bureau of Standards (see Standards Organizations).

Network Management

- The facility by which network communication and devices are monitored and controlled.

Objective

- A desired end result, condition or goal which forms a basis for managerial decision-making.

Octet

- A group of eight bits treated as a unit (see Byte).

Open Loop System

- A control system which has no means of comparing the output with the input; i e., there is no feedback.

Open System

- A system that obeys public standards in its communication with other systems and/or between layers.

Operating System - 1.

Software which controls the execution of computer programs and which may provide scheduling, debugging, input/output control, accounting compilation, storage assignment, data management and related services. 2. The master control program of a computer which controls all hardware activity.

Operator - 1.

In the description of a process, that which indicates the action to be performed on operands. 2. A person who operates a machine.

Opportunity Cost

- The return on capital that could have resulted had the capital been used for some purpose other than its present use. Sometimes refers to the best alternative use of the capital; at other times to the average return from feasible alternative.

Optimization

- A method by which a process is continually adjusted to the best obtainable set of operating conditions.

Organization

- 1. The classification or groupings of the activities of an enterprise for the purpose of administrating them. Division of work to be done into defined tasks along with the assignment of these tasks to individuals or groups of individuals qualified for their efficient accomplishment. 2. Determining the necessary activities and positions within an enterprise, department or group, arranging them into the best functional relationships, clearly defining the authority, responsibilities and duties of each and assigning them to individuals so that the available effort can be effectively and systematically applied and coordinated.

OSI

- Open System Interconnect.

OSI Reference Model

- A seven layered model of communications networks defined by ISO. The seven layers are:
Layer 7 - Application: provides the interface for the application to access the OSI environment.
Layer 6 - Presentation: provides for data conversion to preserve the meaning of the data.
Layer 5 - Session: provides user-to-user connections.
Layer 4 - Transport: provides end-to-end reliability.
Layer 3 - Network: provides routing of data through the network.
Layer 2 - Data Link: provides link access control and reliability.
Layer 1 - Physical: provides an interface to the physical medium.

Parameter - 1.

A variable that is given a constant value for a specified application. 2. A variable that controls the effect and usage of a command. 3. Alterable values that control the effect and usage of a graphics command. 4. A constant whose values determine the operation or characteristics of a system. In $y = ax^2 - bx + c$; a, b, and c are the parameters of a family of parabolas. 5. A variable, t, such that each variable of a related system of variables may be expressed as a function of t.

PCA

- Process Communications Architecture. An architecture for a three layer (Physical, Data Link, and Application) open communications system being developed by ISA SP72. It can provide communications functions that are needed in control and automations applications. PCA uses OSI protocols and provides a transparent application interface to 7-layer MAP networks.

PDU

- *P*rotocol *D*ata *U*nit. Each of the seven OSI layers accepts data SDUs (SubData Unit) from the layer above, adds its own header PCI (Protocol Control Information) and passes the data to the layer below as a PDU. Conversely, each of the layers also accepts data from the layer below, strips off its header, and passes it up to the layer above.

Planning

- The procedure for determining a course of action intended to accomplish a desired result.

PMS

- Process Messaging Service (see ISA SP72).

Preventive Maintenance

- Maintenance specifically intended to prevent faults from occurring during subsequent operation.

Process Control

- Pertaining to systems whose purpose is to provide automation of continuous operations. This is contrasted with numerical control, which provides automation of discrete operations.

Production - 1.

The manufacturing of goods. 2. The act of changing the shape, composition, or combination of materials, parts, or subassemblies to increase their value. 3. The quantity of goods produced.

Production Capacity

- The highest, sustainable output rate which can be achieved with the current product specifications, product mix, worker effort, plant, and equipment.

Production Planning - 1.

The systematic scheduling of men, materials, and machines by using lead times, time stand-

ards, delivery dates, work loads, and similar data for the purpose of producing products efficiently and economically and meeting desired deliver dates. 2. Routing and scheduling.

Production Schedule

- A plan which authorizes the factory to manufacture a certain quantity of a specific item. Usually initiated by the production planning department. (*cf*, shop order, work order, manufacturing order, job order).

Protocol

- A formal definition that describes how data is to be formatted for communication between a data source and a data sink.

PROWAY

- A standard for a process control highway based on *IEEE 802.4* token bus immediate acknowledged MAC (Media Access Control), a physical layer utilizing a phase-contiguous signaling technique. Developed by ISA SP72.

Quality Control

- The procedure of establishing acceptable limits of variation in size, weight, finish, and so forth for products or services and of maintaining the resulting goods or services within these limits.

Real Time

- 1. Pertaining to the actual time during which a physical process transpires. 2. Pertaining to computation performed while the related physical process is taking place so that results of the computation can be used in guiding the physical process.

Repeater

- A device that amplifies or regenerates data signals in order to extend the distance between data stations.

Response Time

- The total time necessary to send a message and receive a response back at the sender exclusive of application processing time.

Rework - 1.

The process of correcting a defect or deficiency in a product or part. 2. Units of product requiring correction.

Router

- A network device that interconnects two computer networks that have the same network architecture. A router requires OSI Level 1, 2 and 3 protocols (see Bridge and Gateway).

RS511

- A messaging standard, also known as MMS, under development in EIA for communication between factory floor devices. It uses ASN.1 for data encoding (see ASN.1 and MMS).

SAP

- Service Access Point. The connection point between a protocol in one OSI layer and a protocol in the layer above. SAPs provide a mechanism by which a message can be routed through the appropriate protocol as it is passed up through the OSI layers.

SC

- Standing Committee.

Scheduling

- The process of setting operation start dates for jobs to allow them to be completed by their due date.

Simulation

- The representation of certain features of the behavior of a physical or abstract system by the behavior of another system.

SME

- Society of Manufacturing Engineers (see CASA/SME).

SNAP

- Sub-Network Access Protocol. SNAP provides a mechanism to uniquely identify private protocols above LLC.

Source Address

- The physical (hardware) address of the node that transmitted the frame (see Frame).

Standards Organizations

- Many different national and international organizations are involved in the task of MAP, TOP and LAN standards. Some of the key organizations are:

ANSI - American National Standards Institute. ANSI X3T9.5 is working on high speed (50 to 100 Mbit/second) LAN standards.

CBEMA - Computer and Business Equipment Manufacturers Association. CBEMA committee X3T9.5 is working on high speed (50-100 Mbit) LAN standards.

CCITT - International Consulting Committee on Telephone and Telegraph. CCITT standards important to MAP and TOP are the X.25 family of standards that are used to gateway MAP or TOP to wide area networks (WANs) and X.409 which provided the basis of ASN.1.

ECMA - European Computer Manufacturers Association. ECMA is also working on LAN standards in cooperation with IEEE 802.

ESCA - Exchange Carriers Standard Association.

EIA - Electrical Industries Association. Work is currently in progress in EIA on RS511, a messaging standard for use between factory floor applications.

IEC - International Electrical Technical Commission. An IEC standards committee (IEC TC97/WG6) has defined a LAN for use in process control environments (PROWAY) in cooperation with IEEE 802.4 and is working on a Field Bus standard. Also known as EIC.

IEEE - Institute of Electrical and Electronic Engineers. An IEEE standards committee (IEEE 802) is chartered to work on LAN standards for data rates of to 10 Mbit/second and had produced the standard for CSMA/CD (IEEE 802.3) used by TOP and the standard for Token Bus (IEEE 802.4) used by MAP. These standards have also been approved by ISO (DIS 8802/3 and DIS 8802/4).

ISA - Instrument Society of America. The ISA is responsible for the PROWAY standard in the United States. ISA SP50 is working on a field bus standard. ISA is the American cognizant organization for EIC-developed standards.

ISO - International Organization for Standardization. ISO takes standards submitted by its member national standards bodies, ballots the standards internationally, and approves international standards. The major ISO standards used by MAP are ISO FTAM (DP 8571), ISO Session (IS 8327), ISO Transport (IS 8073) and ISO Internet (DIS 8473).

NBS - National Bureau of Standards. An organization of the United States government that is responsible for the standards used by other government agencies (e.g., FIPS, Federal Information Processing Standards). NBS also provides compliance testing services, and hosts standard development workshops.

SME - Society of Manufacturing Engineers (see CASA/SME).

Station Management

- The portion of Network Management that applies to the lowest two OSI layers.

Statistical Quality Control

- A means of controlling the quality of a product or process by the application of the laws of probability and statistical techniques to the observed characteristics of such product or process.

Sublayer

- A subdivision of an OSI layer (e.g., the IEEE 802 Standard divides the link layer into the LLC and MAC sublayers)

Subsystem

- A collection of logically connected functions that implement a particular function in the system.

System

- An organized collection of personnel, machines, and methods required to accomplish a set of specific functions.

System Development

- A formal, phased approach to producing a significant new system or major changes to an existing system. It stresses teamwork among users and technical personnel, a series of major milestones, and through documentation to assure compliance with performance and schedule goals.

System Engineering

- The process of selecting and integrating functionally distinct devices, mechanism, and subsystems necessary for optimum performance of the operation.

System Requirements Definition Phase

- The portion of system development whose purpose is to investigate a company, or part of a company, in sufficient depth to develop a firm business proposition involving a changed method of operation. It results in a statement of the functional requirements of new systems.

TAGS

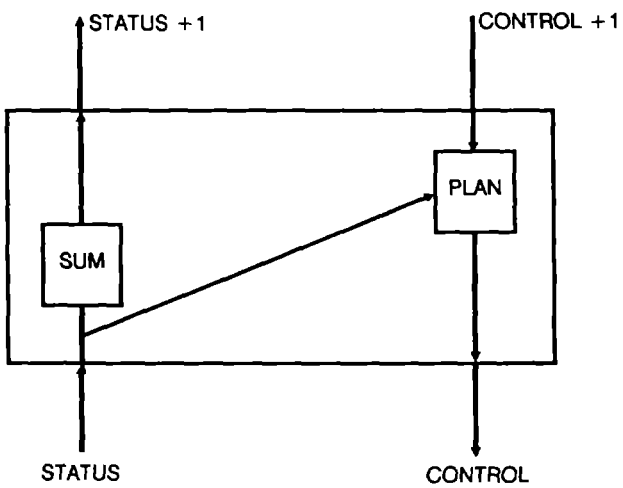
- Technical Assistance Groups. (See IEEE 802).

TC

- Technical Committee.

Time-Phased Decomposition

- Involves reducing the complexity of a system by decomposing the solution into a number of hierarchically arranged modules. Each level of the hierarchy represents:
A. A shift in the time domain (lower-level layers are closer to real-time).
B. A corresponding narrowing of the "scope-of-control" in lower levels.
C. Each level provides planning (control) input to lower layers and accepts process status from lower layers. For Example:



Token Bus

- An access procedure where the right to transmit is passed from device to device via a logical ring on a physical bus.

TOP

- Technical and Office Protocol. A development of the CSMA/CD (Carrier Sense Multiple Access with Collision Detection) protocol (also IEEE 802.3) under the auspices of Boeing Computer Services for office and laboratory automation use. This has been combined with MAP and further development will be under the auspices of the MAP/TOP Users Group.

TTP

- Telephone Twisted Pair. A network medium that uses existing telephone wiring. Standards work is in process on a TTP standard for IEEE 802.3 STANDLAN and IEEE 802.5 token ring.

WG

- Working Group.

Wiring Closet

- The room or location where the telecommunication wiring for a building, or section of building, comes together to be interconnected.

Workstation

- The assigned location where a worker performs his job. A man-machine interface system for carrying out computer related functions.

World Federation

- The joining together of the three international regions related to MAP and its promotion and standardization: (1) The Americas (Canadian MAP interest group and U.S. MAP/TOP Users Group) and Western Pacific (Australian MAP Interest Group), (2) Asia (Japan MAP users Group), and (3) Europe (European MAP Users Groups).

*Please also see Table 4-II for definitions of the terms used in Chapter 4 of this work.