5

The Implementation Hierarchy View of the CIM System

GENERAL

Figure 5-1 represents one concept of the components or elements required for the implementation of the CIM system for each "bubble" or Manufacturing Specific Functional Entity of the data-flow diagram of Chapter 4 or each Task of Chapter 3.

This concept allows each task to be expressed in as many layers as required (11 maximum). Layers may be used or nulled as necessary. Thus such a model needs to be developed in specific form for each "bubble" of the data-flow diagrams presented in the previous chapter using the generic model of Figure 5-1 as a base and supplying the appropriate implementation details. Likewise this would be done for each task in Tables 3-VI to 3-X since these are equivalent to the above. Only examples of such models will be presented in this Chapter.

Just as the ISO-OSI model (Figure 9-6) [8] breaks the tasks of the communications between systems into layers, this model breaks the tasks of plant control into functional layers. A brief discussion of each layer of the model follows.

DESCRIPTION OF THE LAYERS

As diagrammed in Figure 5-1 the CIM model is represented in the implementation hierarchy view by an eleven layered structure. The hardware elements of the system are represented by the lower five layers of the system (1-5), while the software elements are represented by the top six layers (6-11).

Layer 1 — Physical Environment (Including Humans)

This layer would typically represent the process equipment (i.e., reactors and distillation columns), machine tools (i.e., CNC and human operators) and supporting areas such as utilities and packaging. As noted often earlier, these elements would be non generic in any specific case and are included here for completeness.

Layer 2 — A - Data Input/Checking/-Output
B - Links to Other Levels

2A. The detection and measurement of the status and of the actions occurring in Layer 1 are contained in this layer. This layer represents the eyes and ears of the CIM System. This includes the determination of the values of such variables as temperature, level, pressure, chemical analysis, position, weight, etc., from sensors and detectors. Also included are inputs from touch screens, mice, bar code readers, etc. Typical system actuators would include valves and valve positioners, hydraulic drives, solenoids, relays, CRTs, printers, etc.

2B. Where higher level functions are involved such as overall production scheduling in large

industrial production plants (Figure 5-2), then Layer 2 represents the link to other computer and control equipment involved in implementing the task described. In the case of Overall Production Scheduling (which itself takes place in Levels 4A and 3 of the hierarchical system of Figure 3-1 or 3-2) this would include all elements of Levels 1 and 2 of the latter diagram.

Layer 3 — Communications

Layer 3 moves the data within the system. The clients of this communication system would be the various computer systems and databases which manipulate and store this information and the various functional entities which use the resulting information. Likewise data to and from the operating units of the plant must be brought back to Layers 1 and 2 and other layers by the communications systems. Also included in this layer are device gateways and drivers as/if required. Real time and transactional communications are to be determined by the characteristic of the task.

The communications structure should, as far as possible, follow the OSI model and agreed upon industry-wide standards for their implementation.

Layer 4 — Process/Task Database

The global database of the factory or plant resides in this layer. It becomes the collective memory for the CIM system. This database will be distributed as determined by the implementation plan. The authority and responsibility for the several data maintenance functions will be determined by job function.

Layer 5 — Computer System Elements

Exact content at this layer will be determined by the functional requirements of the system, but must encompass the entirety of the intelligent computing devices contained in the CIM System which are required for the task at hand. Examples include computers, disks and database machines.

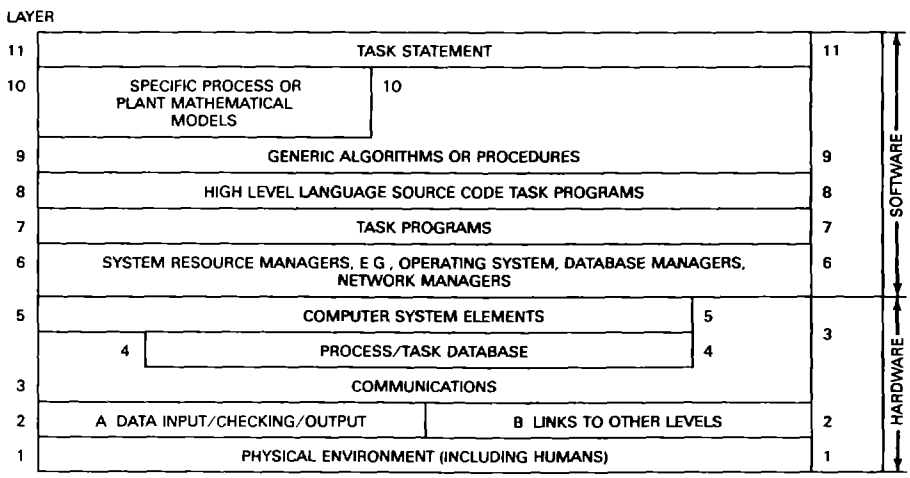

Figure 5-1 Proposed generic form of the implementation hierarchy view of the CIM system.

Layer 6 — System Resource Managers

This layer contains the software which allocates and manages the elements which comprise the system. Examples are operating systems, database management systems, network managers, system utilities and data dictionaries.

Layer 7 — Compiled or Interpreted Code

This layer represents the program as actually executed by the computer system. It may be stored in random access or read only memory as required by the application at hand.

In some special applications, programs may need to be cross compiled and run on two or more different machines under different operating systems.

Layer 8 — High Level Language Source Code

This layer contains the source code in the form of a high level language such as Ada, FORTRAN, C or 4th generation languages.

Layer 9 — Generic Algorithms/Procedures

Each process has calculation, algorithmic or modelling requirements. These would reside in this layer and service the lower layers. Examples would be linear programs as used for a catcracker optimization routine or a dynamic optimization technique as used for robot optimal path determination.

Layer 10 — Specific Process or Plant Mathematical Models

For certain applications models must be included as required. These models allow simulation of the process to generate information not otherwise

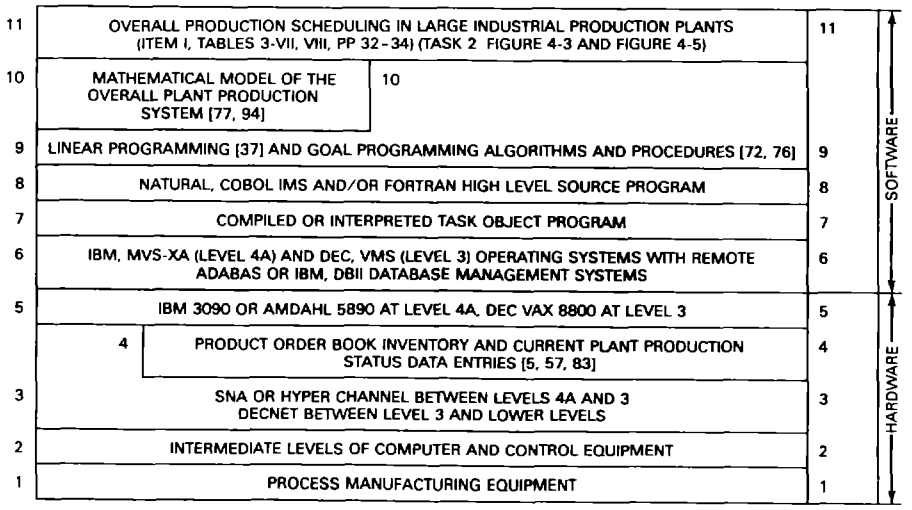

Figure 5-2 Use of the implementation hierarchy view to illustrate the overall production scheduling task [89].

available. Uses would be supplying unmeasurable data, verify existing data or predicting future data. Examples are process unit models for advanced control systems or business models for scheduling functions.

Layer 11 — Task Statement

Description or specification of the task or function to be accomplished (the application functions of the manufacturing plant) would reside at this layer.

SOME EXAMPLE IMPLEMENTATION HIERARCHY VIEWS

Figures 5-2 and 5-3 present two examples of Implementation Hierarchy Views from among the tasks developed in Chapters 3 and 4. Those chosen are Overall Production Scheduling (Item I, Tables 3-VII, VIII, and Task 2, Figure 4-3 and Figure 4-5) in Figure 5-2 [89] and Control Enforcement (Item II, Table 3-X and Task 3.3.3, Figure 4-9) in Figure 5-3. As noted above these are presented as examples and no attempt will be made here to produce examples for all the possible functions since they tend to be implementation specific as shown by Figures 5-2, and 5-3.

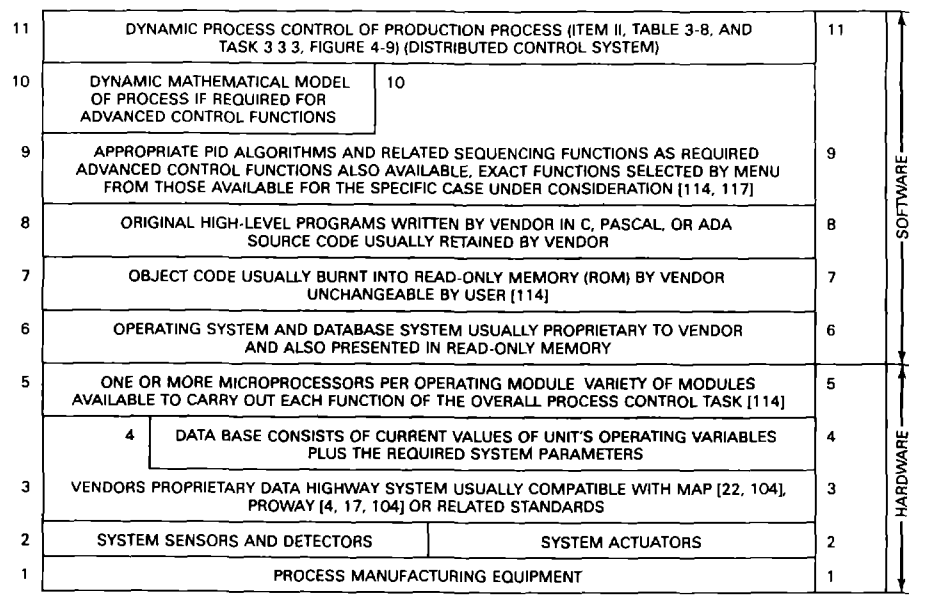

Figure 5-3 The implementation hierarchy view of the dynamic process control task in the manufacturing plant.