

CIMA—AN INTEGRATED ARCHITECTURE FOR PRODUCT REALIZATION

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The Computer Integrated Manufacturing Architecture is a planning tool for AT&T's design and manufacturing systems of the near future. It covers a hierarchy of operations, ranging from basic assembly up to production loading and product design and coordinates these operations within hierarchical levels and between levels. CIMA is aimed at helping AT&T to ensure fast, efficient introduction of products, low-cost manufacturing operations, fast and complete response to customer orders, and high quality.

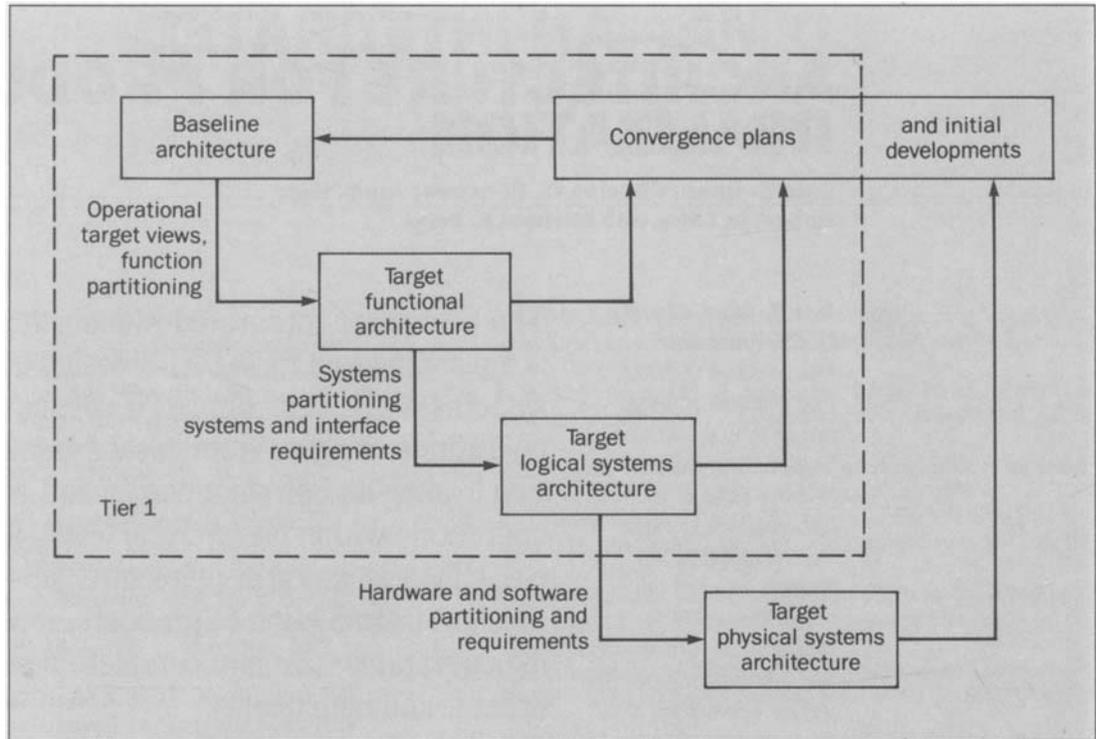
The CIMA Project

Today's business environment requires that AT&T improve its operations in design and manufacturing to better respond to competitive pressures. These improvements, together with technological changes in products and in manufacturing processes, require that AT&T also improve its existing computer support systems for design and manufacturing. The Computer Integrated Manufacturing Architecture (CIMA) effort was initiated in late 1984 to help formulate architectures for AT&T's design and manufacturing operations and systems of the early 1990s and to plan an evolutionary path toward this goal.

The task of planning and developing computerized support systems for integrated, efficient operations is not new to AT&T. Not long ago, detailed analyses of local telephone companies' operations, from order processing to maintenance, led to the development and installation of a network of operations support systems and to critical efficiency improvements. The operational and systems expertise that made this possible is now being applied to CIMA. The approach (see Figure 1) to this new, technically more difficult challenge, is similar to the one used before:

- Current operational processes have to be analyzed and their limitations clearly understood.
- Business-related operational target views need to be constructed, and accepted by all participants.
- A target functional architecture has to be created to describe what functions are required in the future, what their information

Figure 1. The Computer Integrated Manufacturing Architecture (CIMA) approach to planning and developing computerized support systems.



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exchanges should be, and what they will need in terms of systems support, procedures, and measurements.

- A target logical systems architecture needs to be constructed, to cluster the required system functionalities into conceptual systems and to specify the interconnection and environment needs of such systems.
- The above architectures need be used as (1) templates for current architectures in design and manufacturing so that the necessary evolution can be planned and efficiently implemented, and (2) as guides for the development of procedures and measurements consistent with the operational target view and for the systems engineering and development of the future operations support systems.

Operational Target View

Customer satisfaction and corporate financial success are the goals that drive the four key targets of CIMA for design and manufacturing operations:

- Fast, efficient introduction of products
- Low-cost manufacturing operations
- Fast, complete response to customer orders
- High quality.

These key targets, based on line personnel feed-

back and process analyses, in turn drive the target architectures.

Fast and efficient product introduction requires the strict enforcement of comprehensive up-front product planning, formation of teams of product and process designers and materials and deployment planners to provide a multi-disciplinary core to the product introduction effort, appointment of product realization team managers with real cross-organizational authority, and detailed methodologies to assure that product and process design adequacy reviews are performed and successfully completed. The target also requires enhanced systems for the paperless creation of design information, improved communication between design and manufacturing engineers, full issue control of information, and storage of the “how to build the product” information to optimize subsequent factory operations.

Low-cost manufacturing operations in assembly factories require low direct and indirect costs of materials. This is critically dependent on product design: designers must take into account direct and indirect materials costs to factories in all design decisions, from initial product architecture to component selection. On the factory side, this target depends on a resources management discipline

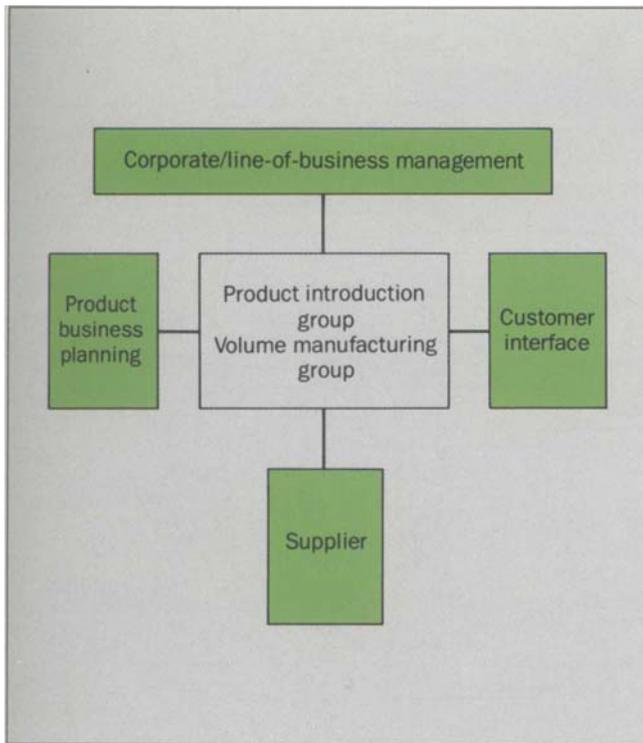


Figure 2. CIMA functional architecture overview. Green blocks in Figures 2, 3 and 4 represent functions outside CIMA.

that results in stockless (“pull”) production and supply operations. It is critical that islands of stockless operations be established wherever possible and that these islands be progressively expanded and linked. This discipline requires that accountability for work-in-progress inventories be pushed down to the lowest organizational levels and that measurements and rewards be consistent with this goal. It also requires new, integrated operations support systems for floor execution, monitoring and control, and flexible operations and materials management systems.

Fast, complete response to customer orders requires modularity and standardization of designs, and reduction in the number of product selling configurations. Given these two requirements, the target also requires integrated customer order management, including advanced reservation, sourcing and scheduling, order issue control and tracking, order manufacture, and delivery, so that customers can be adequately served by the sales organizations while manufacturing optimizes its own resource utilization. From a systems perspective, this target requires a very high level of integration of order management, design, and production planning systems. It also requires that adequate support systems be installed to monitor and control final assembly and test operations.

High quality is a target that affects all design and manufacturing operations. It requires clear up-front definition of customer expectations about the product functionality and support, methodologies that stress a zero defect goal, and attention to yield and other manufacturing requirements. The target also implies a culture of preventive attention to performance degradation, and technically strong engineering support aimed at constant process improvements. Systems must support exception reporting of quality degradation and quick follow-up corrective actions.

An underlying objective that supports all the above targets is *simplification of products and processes*. Simplification will result in significant savings in costs and intervals, and higher quality.

Functional Architecture

The CIMA functional architecture proposes a structure of functions and information exchanges between functions that supports the achievement of the operational target view. The functional architecture provides the foundation for work center, procedure, and measurement planning. It is also a step toward the CIMA logical systems architecture.

The CIMA target functional architecture abandons the traditional distinction between design and manufacturing and proposes instead that functions be separated into *Product Introduction* and *Volume Manufacturing* groups (Figure 2). This nontraditional functional grouping is necessary if the integration requirements presented in the target view are to be fully realized.

The CIMA Product Introduction functional architecture is shown in Figure 3. It contains four parallel functional cycles: hardware and software design and development, manufacturing facilities design and development, materials procurement, and deployment enabling.

These four functional cycles are triggered by the product business plan, controlled by a strong Project Management function, and brought to a close by a Product and Process Integration Verification (PPIV) function. Each one

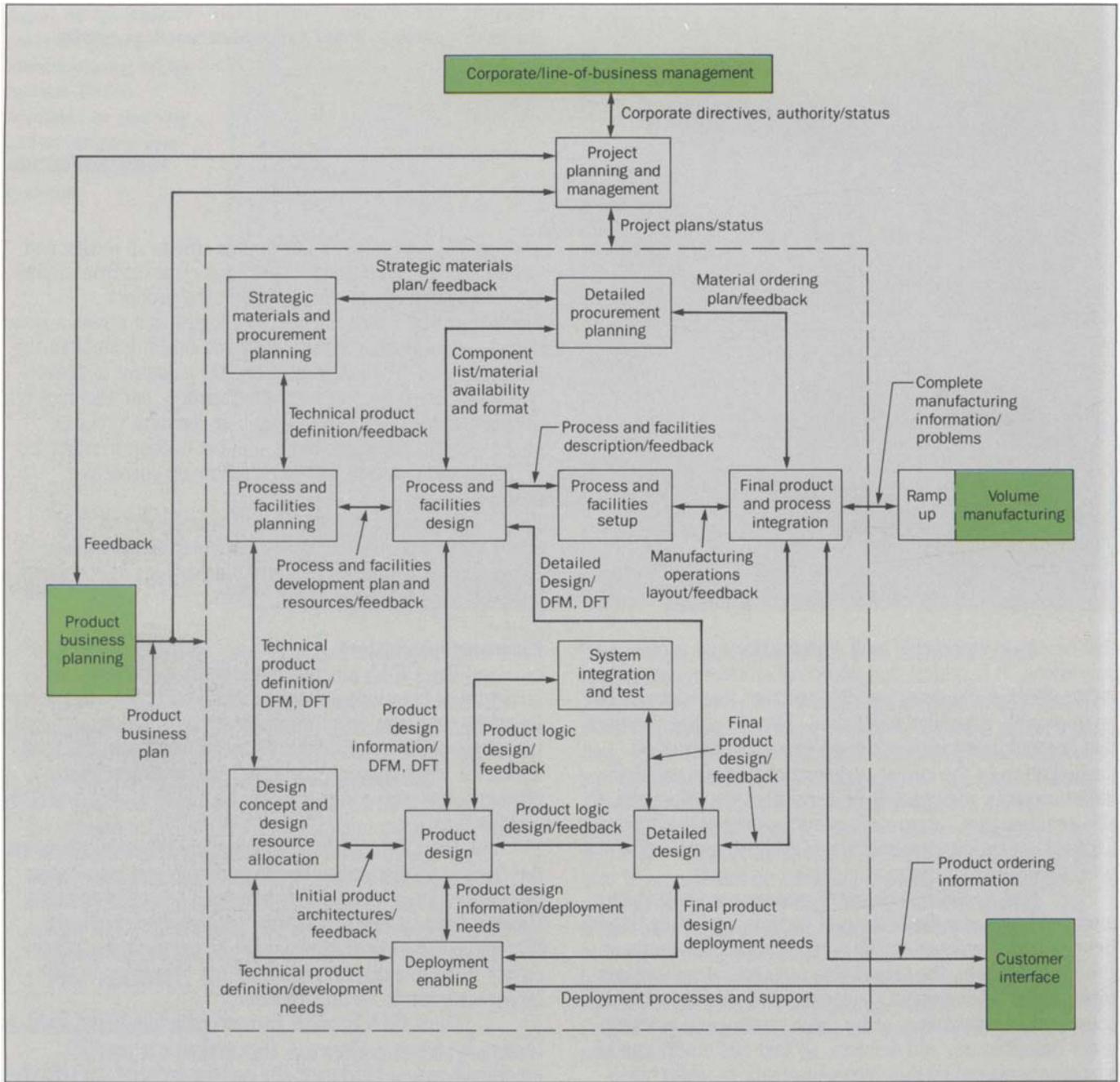


Figure 3. Product Introduction functional architecture.

of the four cycles contains early planning, high-level design, detailed design, and verification functions. The information exchanges emphasize product/process communication, closing of information loops, and issue control of information. The Product Introduction functional architecture provides a formal structure for the evolution of the up-front product business plan information into the full set of information that enables the factory to make the product.

The CIMA Volume Manufacturing functional architecture is shown in Figure 4. It contains the functions needed to specify what products to make, when, and in what quantities (Production and Materials Management, Manufacturing Order Service, and Order Release), the functions that control and execute production (Floor Execution Control, Receiving Control and Execution, Stores, Manufacture and Test, and Material Transport), procurement (Procurement Control), and manufacturing distribution (Distribution Control and Packing and Shipping). Technical support functions, such as Engineering, Quality, and Facility and Systems Maintenance, as well as Manufacturing Management and Administrative Support, are also included. The architecture emphasizes the closing of key information loops in production planning, procurement, production execution, and distribution, as well as the loops with customer orders and Product Introduction.

Logical Systems Architecture

The CIMA logical systems architecture proposes a structure of conceptual (logical) systems linked by information exchange networks. Logical Systems provide support to one or more functions in the Functional Architecture.

Distribution and integration are key concepts of the target logical systems architecture. Logical systems are distributed in a CIMA seven-level hierarchy that encompasses design systems outside the factories all the way down to systems that control manufacturing workstations. Integration is emphasized by a single architecture for both Product Introduction and Volume Manufacturing logical systems, with several systems straddling the

boundary and with an overall information and control management system, which provides a new and critical functionality.

Figure 5 presents a high-level view of the logical systems hierarchy. The lowest level of the CIMA hierarchy contains equipment, such as a robot, a cart, or a bar-code reader, which is to be linked to CIMA systems. Equipment performs operations that change the form of, location of, or knowledge about one workpiece. At the next higher level are workstation systems. These control and monitor the operations of the equipment under their supervision. Next are cell systems, not yet broadly implemented in our factories but the subject of much current work. Cells control workstations and, therefore, tightly related operations on several workpieces.

At level 4 are the shop systems that monitor and control natural sets of factory production functions. In CIMA terminology, receiving, shipping, storerooms, subassembly lines, final assembly line, and so forth are “shops.” To manage product flows between shops within the time granularity of the instructions from level 6 systems, CIMA introduces the floor systems. “Floors” tie together the shops and are critical to balancing short-term load among shops and to ensuring pull production.

The next two levels of the CIMA hierarchy plan, support, and enable manufacturing operations. The highest level, corporate systems, acts across factories and results in production loading to factories, designs, order management, and so forth. Level 6 occurs in the factory, either at the whole factory or at a factory-within-factory level, and includes such systems as materials planning, engineering, and so forth.

The CIMA logical system architecture populates these seven levels with two kinds of logical systems. The operations-support logical systems, as the name indicates, support specific sets of functions in the functional architecture. In addition, these systems interface with other systems and manage their own data. The information and control management system integrates the total information environment.

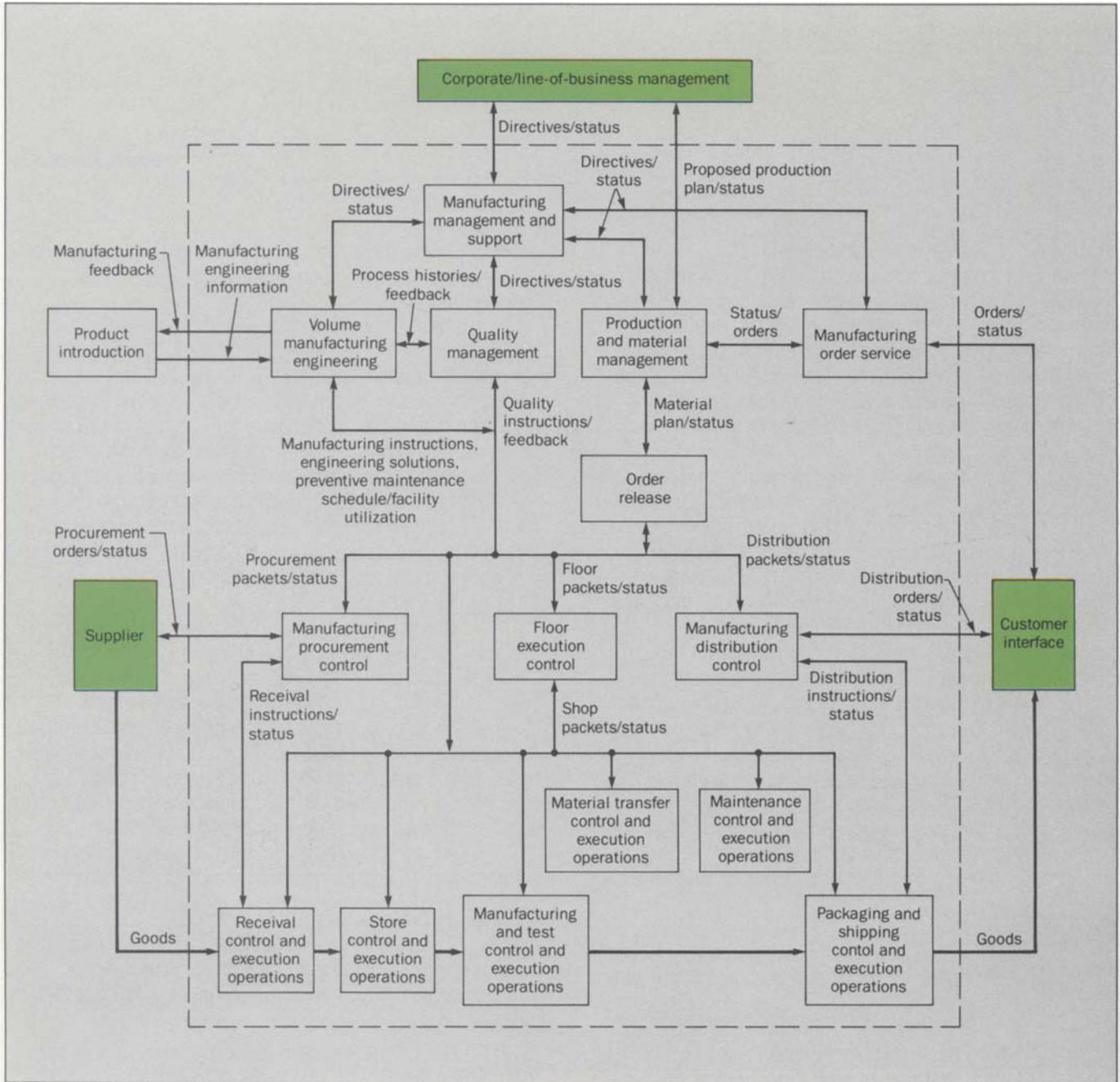


Figure 4. Volume Manufacturing functional architecture.

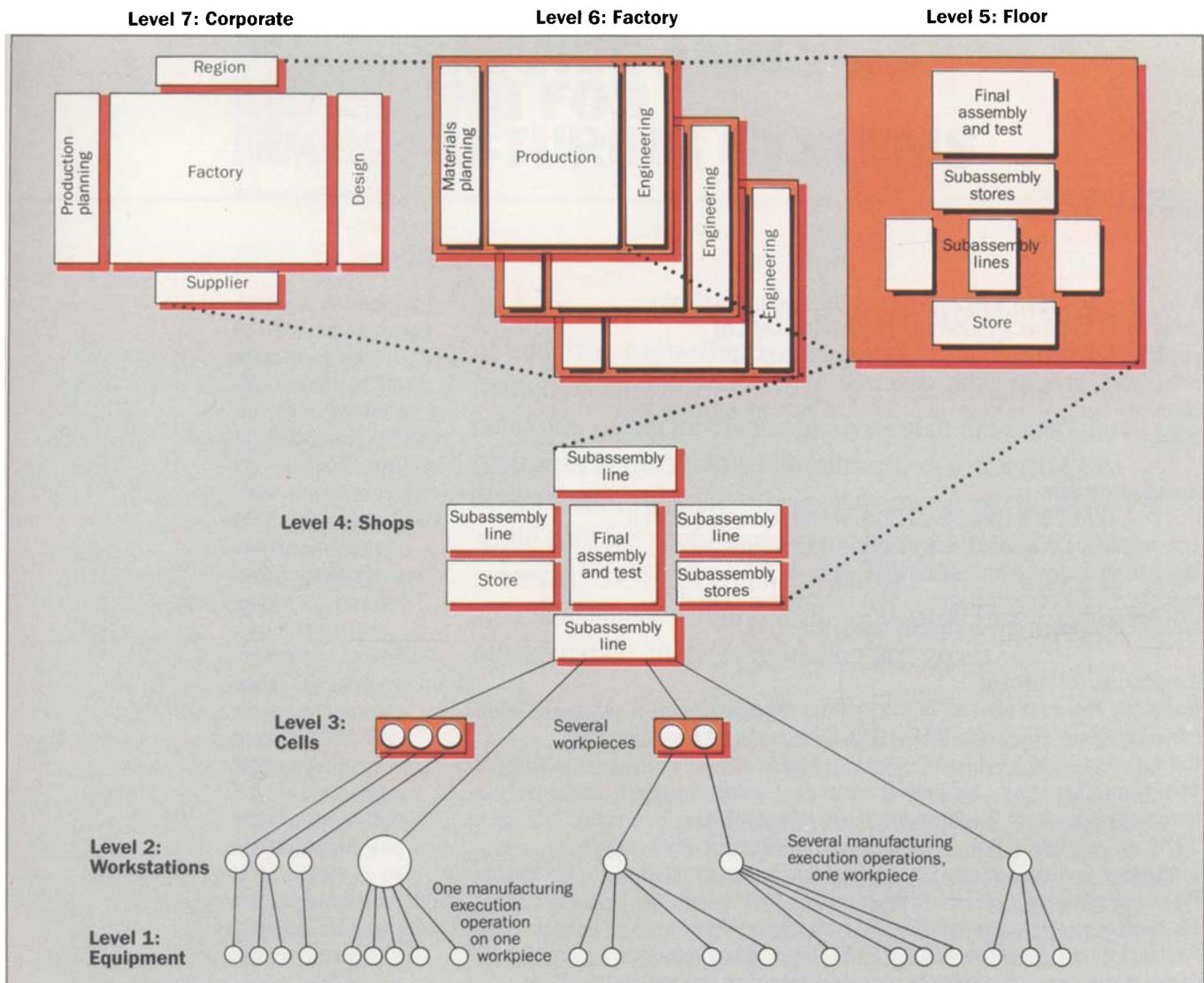


Figure 5. The CIMA logical systems hierarchy.

The CIMA logical systems architecture deals in an integrated way with three main kinds of information flows: engineering information (which tells the factory all details on how to make products), production planning information (which tells the factory what products to make, when, in what quantities, and with what resources), and decision support information (which includes status reports, exception reports, and action-enabling information). The action-enabling information makes possible prompt response to

performance degradation and troubles.

The approach to CIMA implementation must rely heavily on standardization of interfaces, reusability of applications software, and provisioning of plug-compatible hardware.

Next Steps

The CIMA functional architecture will continue to be used as a guide for development of enhanced operational procedures. For instance, guidelines for the introduction of new products are being developed in coordination with CIMA and will trigger further procedure development.

The CIMA logical systems architecture will continue to be used as a guide for the development of enhanced or new operations support systems. As seen in subsequent articles in this issue, new systems and/or features are being developed and installed with integration in mind.

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Biographies (continued)

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