THE BUSINESS RESOURCES PLANNING SYSTEM

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Concepts of business resources planning are cornerstones of the AT&T project that has become known as BRPS (Business Resources Planning System). Under the BRPS project umbrella is a family of integrated initiatives that address the manufacture and distribution of AT&T products in a market-focused environment. Elements of the BRPS project specify the functional architecture, the management processes, policies, procedures, and accountabilities necessary to mold the functions of business planning and execution into a total closed-loop control system. The scope of the BRPS project spans a gamut of manufacturing planning and execution functions, from interfaces with sales and marketing to interfaces with material suppliers. Included within the purview of the BRPS system model are modules for planning, control, and performance measurement for demand management, distribution network operations, and material acquisition and facility management. Through a hierarchically defined specification of the processes and data needed for a total business system, BRPS provides criteria for identifying software solutions and procedural solutions.

History

The BRPS project was undertaken in 1982 to address the processes, accountabilities, material flows, and supporting systems that plan and control distribution, material, and manufacturing resources required to produce and deliver AT&T-manufactured and supplied products in a competitive marketplace.

In order to better prepare the manufacturing and supply arm (then Western Electric) of the AT&T corporation to meet the changing nature of the communications environment of the '80s and beyond, a new organization was established to generate concepts and plans aimed

at making major improvements in manufacturing planning and control policies and system tools. By 1984, the Business Resources Planning System organization had developed a complete manufacturing and distribution model which reflected the goals and advanced thinking of AT&T manufacturing organizations as well as those of noted experts outside the company. Since its inception, the BRPS model has been a bench mark for measuring the applicability of software tools and for developing consistent policies and performance measures across all sectors of manufacturing.

A significant change in the supplier-customer relationship between AT&T and the Bell Operating Companies resulted from the divestiture of the Bell System in 1984. In addition to divestiture, other significant forces were at work in the marketplace which had an impact on the manufacture and delivery systems of AT&T. These additional factors, which continue to be significant forces affecting AT&T's environment, as well as that of most other high-technology manufacturing companies, include:

- Shorter product life cycles
- Higher material value content of end products
- Proliferation of new raw materials and end product configurations
- Fluctuating interest and inflation rates
- New, highly motivated competitors
- New market and product potentialities.

Goals

The goals of the BRPS project are to provide:

- The framework within which a cost-effective, standard business system, including appropriate measurements, can be developed
- A flexible model which is responsive to changing organizational and physical factory alignments
- A functional planning structure and discipline that identifies data interchanges between functional areas of the company
- An educational program to develop the level of professional expertise necessary to operate in the new environment.

Table I. Improvements Found in Companies Using Manufacturing Resources Planning Processes/Systems

Metrics	Percent improvement
Investment reduction	25
Delivery commitments met	30
Delivery lead-time reductions	25
Reductions in material purchase costs	10

Table I shows average benefits that have been achieved by other manufacturing companies as a result of implementing similar programs, such as Manufacturing Resource Planning (MRP II).

A key element in the progress of AT&T manufacturing and distribution toward the BRPS model has been the ability of people to adapt through educational opportunities to the new vision of the business. Internal corporate and local education and training programs have been instrumental in creating the environment necessary for change. In addition, instructional opportunities outside AT&T have been assimilated, where appropriate, into the fabric of the AT&T educational program. Participation in the American Production and Inventory Control Society (APICS) certification program is recognized and encouraged by the company.

Structured Methodology Used in Design of BRPS Model

Creating the conceptual design of the BRPS model required analysis tools and a documentation methodology. Both the tools and the methodology had to be comprehensive and had to facilitate communication among the designers, who were from diverse organizations and who had different work experience and training.

After careful research into current practices and future trends in systems analysis and documentation, a structured analysis and system specification approach was selected to analyze and document the distribution and

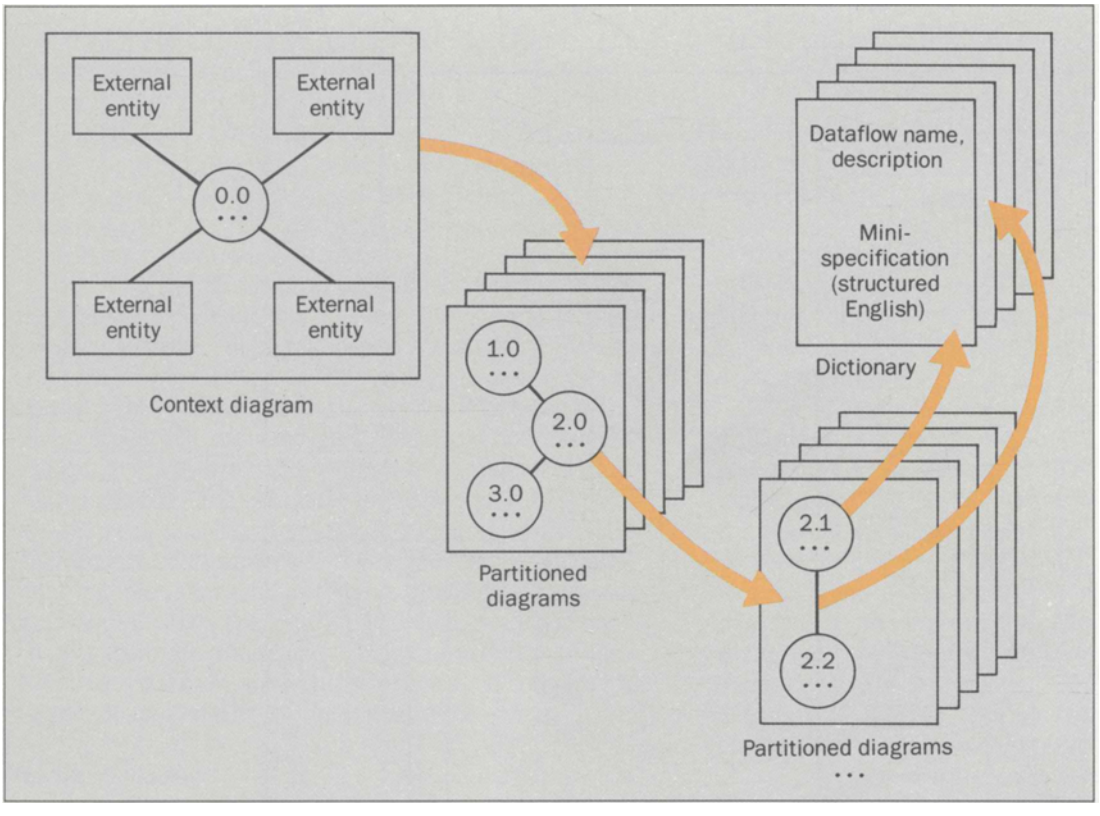

Figure 1. Key elements of the structured analysis technique.

manufacturing processes. For each of the processes to be analyzed and documented, the analysis starts at the "top," at the highest level of abstraction, then moves to more detailed levels of specificity (see Figure 1). The structured analysis methodology:

- Hierarchically partitions the information flows and processes into progressively finer packets of detail
- Is inherently a logical modeling technique which avoids organizational and existing physical limitations of the environment
- Can be presented and understood at multiple levels of definitional granularity
- Easily supports communication between a multiplicity of analysts from diverse backgrounds and disciplines
- Produces documentation elements which are nonredundant and, therefore, highly maintainable.

Figure 1 diagrammatically demonstrates the key elements of the structured analysis technique. An initial high-level context diagram identifies the scope of the model through the specification of the external entities to the set of BRPS processes to be analyzed. The scope of the system is then successively partitioned into smaller processes of greater detail with regard to the process and the definitiveness of the data flows supporting the processes. Ultimately the processes are subdivided into basic singular functions which are described by a minispecifica-

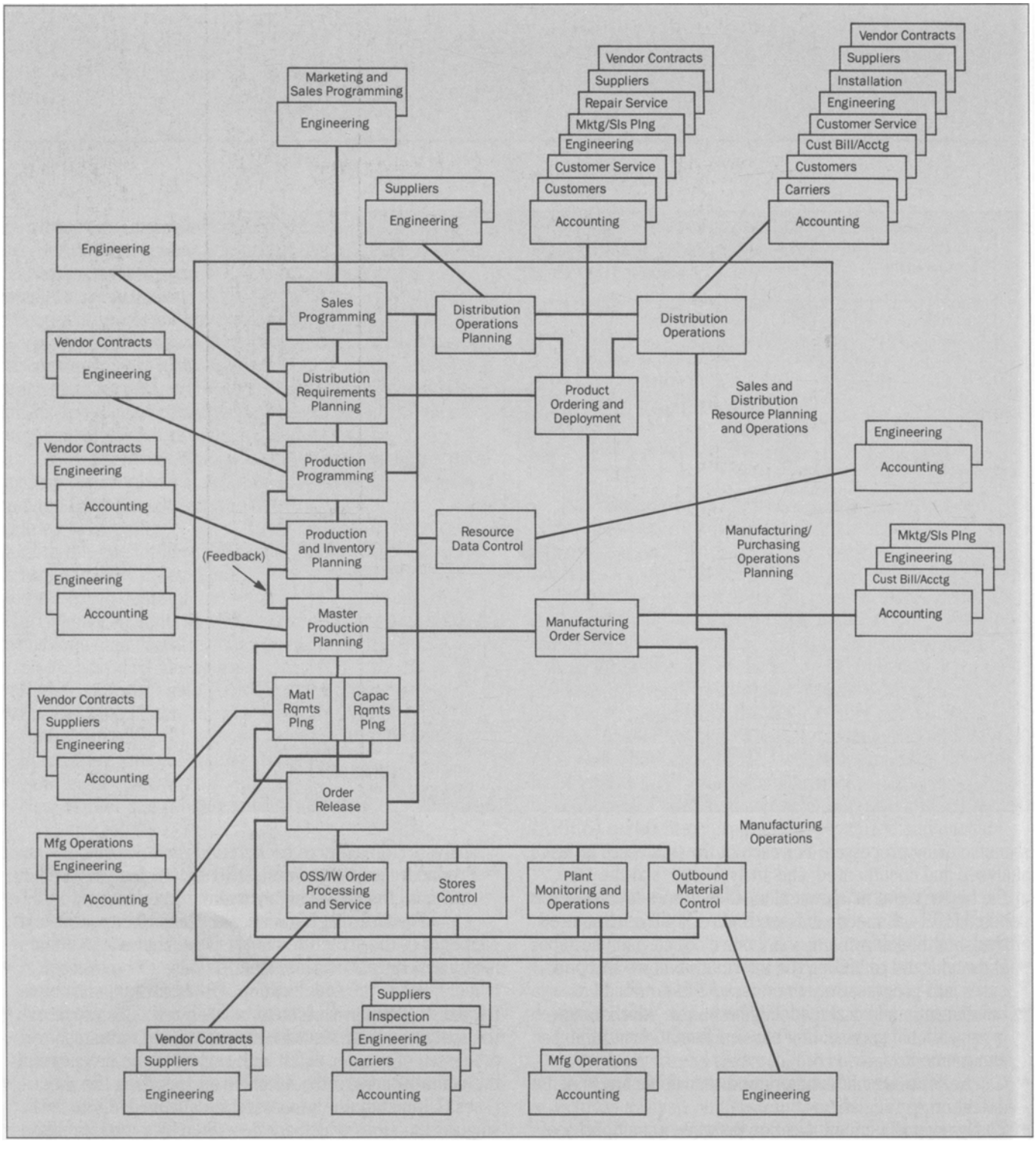
Marketing and Sales Programming
Engineering
Vendor Contracts
Suppliers
Repair Service
Mktg/Sls Plng
Engineering
Customer Service
Customers
Accounting
Vendor Contracts
Suppliers
Installation
Engineering
Customer Service
Cust Bill/Acctg
Customers
Carriers
Accounting
Suppliers
Engineering
Engineering
Sales Programming
Distribution Operations Planning
Distribution Operations
Vendor Contracts
Engineering
Distribution Requirements Planning
Product Ordering and Deployment
Sales and Distribution Resource Planning and Operations
Vendor Contracts
Engineering
Accounting
Production Programming
Engineering
Accounting
Production and Inventory Planning
Resource Data Control
Manufacturing/ Purchasing Operations Planning
Mktg/Sls Plng
Engineering
Cust Bill/Acctg
Accounting
(Feedback)
Engineering
Accounting
Master Production Planning
Manufacturing Order Service
Vendor Contracts
Suppliers
Engineering
Accounting
Matl Rqmts Plng
Capac Rqmts Plng
Order Release
Manufacturing Operations
Mfg Operations
Engineering
Accounting
OSS/IW Order Processing and Service
Stores Control
Plant Monitoring and Operations
Outbound Material Control
Suppliers
Inspection
Engineering
Carriers
Accounting
Vendor Contracts
Suppliers
Engineering
Mfg Operations
Accounting
Engineering

Figure 2. Functional flow of BRPS business model.

tion in a structured English format. The data flows, minispecifications, and data elements are stored in a system dictionary as depicted in Figure 1.

The end-product specification is a logical description of the processes under review; it is displayed in a highly graphical format supported by a limited syntax-based English language description and mathematical representation of data relationships.

The specificity of the structured analysis document allows for a multiplicity of implementations of the framework. Each can be tailored to specific environments. The policies governing a factory are developed by extracting that subset of the processes and accompanying data relationships that apply for the product and operational conditions prevailing at the factory. The implementation site then defines the computer and personnel subsystems to support the subset of processes required for the specific environment. Subsequent to the delineation of the computer and personnel subsystems, software tools are procured to satisfy the identified computer subsystem. Then appropriate procedures, within the context of the established policies, are written for both the computer and personnel subsystems for the target environment.

The BRPS Model

Figure 2 provides a schematic of the functionalism encompassed by the BRPS business model as well as indicating interfaces to processes external to the BRPS scope. Critical to the functional model are the mutual agreements and feedback communication lines between functions. All elements of the supply network must harmonize their activities with a single business plan. The vehicle to synchronize the business functions is the information defined in the BRPS business model.

Sales and Distribution. The Sales and Distribution Resource Planning and Operations sector (grouping of subfunctions) shown in Figure 3 addresses the development of a single, market-oriented sales distribution plan to satisfy customer demand and an achievable supporting operational plan for the distribution network. The following six subfunctions are within the Sales and Distribution Resource Planning and Operations sector.

1. Sales Programming. This subfunction coordinates the development of a mutually agreed upon level of sales between marketing and the material supply network (i.e., distribution and manufacturing). All customer-demand forecasts are assimilated into familial groupings and evaluated against business plan objectives and supplier network capabilities. After a mutual agreement has been reached between the concerned parties, Sales Programming measures the actual customer fill against the agreed-upon commitment levels.

2. Distribution Requirements Planning. The unconstrained demand of the market is uncoupled from the manufacturing environment by Distribution Requirements Planning through the use of finished goods inventory. On the basis of the current sales plan, historical customer demand, customer service objectives, and current inventory positions in the distribution network, an inventory road map for the distribution network is developed. From the inventory road map, a family ordering forecast for stocked material is developed. Projected nonstock material demands are merged with the stock family demands to ensure that a total demand profile is evaluated.

3. Distribution Operation Planning. This subfunction is responsible for planning the operations of the physical distribution network for workers, equipment, and storage capacities. In addition, it is charged with the responsibility for developing transportation recommendations for the total supply and manufacturing network for all product flows.

4. Distribution Operations. The agent for receiving, storing, selecting, packing, and shipping stocked finished goods is Distribution Operations. As storeroom for the finished product inventory in the distribution network, Distribution Operations maintains the accuracy of the inventories in the distribution network warehouses and delivers material to the customer as authorized by actual orders.

5. Production Programming. This subfunction trans-

lates the distribution material demand into manufacturing family terms and parses the demand into the constituent pieces supplied by each manufacturing entity. Thus, independent family level demand is known. In addition, through quantifiable structural dependencies maintained by historical precedent, the dependent support demand that must be coordinated is known.

6. Product Ordering and Deployment. This subfunction analyzes all external customer order demand and, from the established supply scenario for the product, determines how and when the order will be supplied from the distribution/manufacturing network. During the performance of its allocation activities, Product Ordering and Deployment also resolves priority incongruities between all customers—external and interplant.

Manufacturing/Purchasing. The Manufacturing/Purchasing Operations Planning sector shown in Figure 3 establishes a valid production and inventory plan to support the sales and distribution requirements identified in the Sales and Distribution Resource Planning and Operations functions. The key to a successful implementation of the business plan as interpreted by sales and marketing is the concurrence of demand and supply plans between sales and manufacturing (i.e., a commitment by the sales organization to successfully market its projected demand estimates and an analogous commitment by the manufacturing organization to accomplish its manufacturing goals in a timely manner). In successful BRPS implementations, attention to policies and procedures defining objectives and methodology for conducting Sales Inventory and Production Planning meetings ensures that a single plan to support the business plan is successfully communicated to all organizations within the corporation. The following seven subfunctions are within the Manufacturing/Purchasing Operations Planning sector.

1. Production and Inventory Planning. On the basis of the statement of anticipated demands for all families of material, Production and Inventory Planning develops a periodic production rate to satisfy those demands in terms of manufacturing family groupings. From the statement of demand requirements, a bill of resources (i.e., an aggregated statement of product definitions and facility capabilities), and policies governing the flexibility with which the company can effectively respond to demand variation, a time-phased monthly production rate and associated inventory level projection are determined.

2. Master Production Scheduling. Master Production Scheduling creates the anticipated build schedule, which balances the goals of service, inventory turnover, and manufacturing efficiency within the constraints of an approved production plan. The master production schedule drives the item level planning for all manufacturing and procurement of support material and, at the end item level, aggregates to the production plan.

A rough-cut capacity check is performed on the master production schedule by extending the schedule by the critical bill of resources and comparing the aggregate demand for the resources with the facility availability. Given a viable master production schedule, the amount and timing of support material and factory capacity requirements will be calculated by the Material Requirements Planning subfunction and the Capacity Requirements Planning subfunction.

Once the master production schedule has been established, available-to-promise information is calculated for those items that have independent customer demand. As the customer orders are received, they consume the available-to-promise quantities.

3. Material Requirements Planning. Material Requirements Planning is a material scheduling technique for establishing valid requirement dates for dependent support material and for synchronizing the due dates of the supply of that material with the required dates.

Material Requirements Planning, driven by the master production schedule, extends all planned orders by the bill of material to determine the timing and quantity of dependent material that is needed to satisfy the master production schedule. The pipeline of inventory, material on

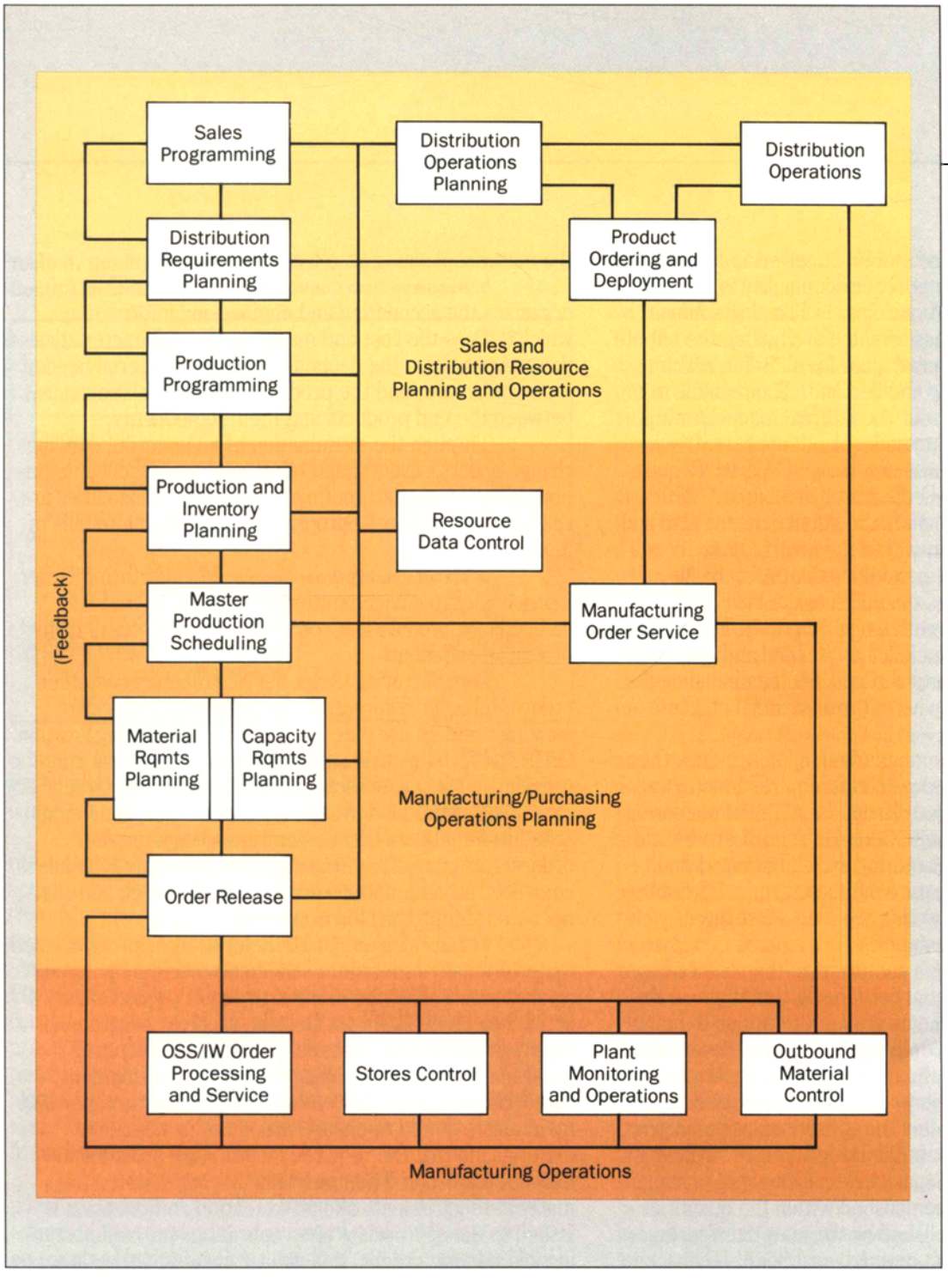

Figure 3. Sectors of the Business Resources Planning System.

order, work in process, and stores, is netted against the required quantities. The net required quantity is then planned by the Material Requirements Planning subfunction. The process continues level by level within the bill-of-material-defined product structures for all items which have an unbalanced supply and demand. The result is a time-phased material plan for the internal manufacturing shops, external vendors, and interplant suppliers.

4. Capacity Requirements Planning. Capacity Requirements Planning determines the factory resource requirements needed to satisfy the detail material plan and then recommends adjustments to the level of capacity to satisfy those requirements, modifies the timing of the consumption of the resources, or redirects the facility requirements to facilities with excess capacity. The material plan that is analyzed includes all planned and released orders from the master production schedule (including the final assembly schedule, where it exists) and material requirement plans.

Capacity Requirements Planning determines the unconstrained time-phased resource requirements by calculating operational due dates from the material plan order due dates and routing information. All planned orders and firm orders in their manufacturing cycle are considered. The individual capacity requirements determined from the operational due date scheduling are then aggregated, yielding a load profile by resource.

The planned load is compared to the planned resource to identify potential bottlenecks and to generate proposed capacity adjustments and/or alterations to manufacturing operations of selective orders to circumvent the bottlenecks. Thus, when the capacity of the facility cannot be altered sufficiently to cover the material requirements, the capacity planner can alter the operational schedules or routing. In order to maintain the integrity of the synchronized material plan, the Capacity Requirements Planning modifications must be accomplished within the quantities and order due dates established by the material plan. In the event the material plan cannot be satisfied, feedback to the material planning functions is necessary.

5. Resource Data Control. Resource Data Control organizes the accounting and engineering information which defines the cost and manufacturing characteristics of the end products, the dependent support material needed for manufacture, and the product structure relationships between the end products and their components.

Through the examination of engineering drawings, change orders, layouts, and other engineering documentation, bills of material, routings, and facility capabilities are specified and, where appropriate, aggregated into bills of resources.

6. Manufacturing Order Service. Manufacturing Order Service allocates uncommitted production to customer demands for product and controls customer orders from receipt to shipment.

Manufacturing Order Service receives customer orders and order reservations for all products which are manufactured for use external to the manufacturing location. On the basis of the material available-to-promise information provided by the master scheduler, Manufacturing Order Service allocates production slots of the end-item production schedule for all customer demand including interplant orders. As material is allocated, a final assembly schedule is composed for assemble-to-order, make-to-order, and engineer-to-order product environments.

7. Order Release. Order Release transforms planned material supply orders into scheduled receipts by issuing an authorization for the manufacturing or procurement activity to proceed. Order Release receives the planned supply orders for the material plan for manufacturing orders or the planned packing orders from a shipment authorization. The requirements for manufacturing or shipment are reviewed to ensure that there is sufficient material and that the required facilities are available to execute the order. Then pick lists are released for the material requirements and an execution authorization is issued to the appropriate shop operations for manufacturing and packing orders. In a similar fashion, Order Release

Table II. Quality Standards for BRPS Data and Process Control Indices

Index	AT&T performance, %
Standard data	
Stores accuracy	95
Bill-of-material accuracy	98
Routing accuracy	98
Process	
Full-stream inventory	95
Production planning	95
Master production scheduling	95
Order release	95
Vendor-supplier performance	95
Factory shipping performance	95

receives the planned supply orders from the material plan for outside supplied material (i.e., interplant and vendors) which are released at the appropriate lead-time interval.

Manufacturing Operations. The Manufacturing Operations sector, Figure 3, addresses the activities required to actuate the detailed material and capacity plans. In addition, Manufacturing Operations is charged with the monitoring and execution of the plans and with providing feedback to the Manufacturing/Purchasing Operations Planning functions when circumstances prohibiting successful completion of the plan arise. The policies and procedures derived to support the Manufacturing Operations function specify the interconnection between AT&T plants, vendor relationships, and internal factory interaction. The following four subfunctions are within the Manufacturing Operations Sector.

1. OSS/IW Order Processing and Service. Outside Supplier/Interworks (OSS/IW) Order Processing and Service executes the placement of released replenishment orders on external suppliers (i.e., vendors and interplant). OSS/IW Order Processing and Service receives the material plan for externally supplied material and, in accordance with established policies, makes the appropriate portion of the plan available to the suppliers of the material. According to the feedback regarding the acceptance of the plan by the external suppliers, OSS/IW Order Processing and Service identifies potential supply problems and tries to resolve these with the suppliers.

When the execution authorization is received for procuring the material, OSS/IW Order Processing and Service first determines the source of supply and then creates a supplier authorization which specifies for the supplier what, when, and how much material to ship.

2. Stores Control. Stores Control is responsible for receiving, storing, picking, and disbursing material in response to authorized material requests. Stores Control is the custodian of the finished goods and support material for the manufacturing entity.

3. Plant Monitoring and Operations. Plant Monitoring and Operations collects the manufacturing and packing activity data and maintains a record of the status of all the released orders. Accumulated shop activity transactions are used to generate manufacturing histories; information on manufacturing proficiency, quality, and maintenance; and data on input-output flow rates.

4. Outbound Material Control. Outbound Material Control coordinates the packing and shipping operations required for meeting customer service objectives effectively and efficiently.

The mode of transportation and specific carrier are selected to suit the type of product, the amount of time required to perform the operations, and transportation policies and costs. Depending on the selected mode of transportation and the nature and quantity of product to be shipped, Outbound Material Control determines the correct packaging requirements.

Progress: BRPS Implementation

The BRPS model is in the process of being

Table III. BRPS Criteria for Ongoing Peformance Measurements (Summarized at Factory Levels)

Performance measure	Standard performance, %	Performance % range			
		Class D	Class C	Class B	Class A
1. Full-stream Inventory*	95	<70	70–84	85–94	95–100
2. Production Planning	95	<70	70–84	85–84	95–100
3. Master Production Scheduling	95	<70	70–84	85–94	95–100
4. Order Release	95	<70	70–84	85–94	95–100
5. Vendor-Supplier Performance	95	<70	70–84	85–94	95–100
6. Factory Shipping Performance*	95	<70	70–84	85–94	95–100
7. Data Accuracy—Stores	95	<70	70–84	85–94	95–100
8. Data Accuracy—Bills of Material	98	<70	70–84	85–97	98–100
9. Data Accuracy—Routings	98	<70	70–84	85–97	98–100
Class points†		0	45	63	99

*Standard performance on Full-Stream Inventory (item 1) and Factory Shipping Performance (item 6) is prerequisite to factory-level class A performance. Any combination of performance mesasurements that yields at least 91 points must include Full-Stream Inventory and Shipping performance at 95% or better.

†Points assigned for performance in the requisite ranges: class D, 0; class C, 5; class B 7; class A, 11. Total points required: class D, <45; class C, 45–62; class B, 63–90; class A, 91–99.

implemented at factories company-wide. Generic policies have been developed under the auspices of the Manufacturing Planning and Operations Systems organization and subsequently adapted by each manufacturing location to its own environment. The model was the basis for the purchase of a manufacturing planning and control system software product for implementation at selected factories. For those factories developing their own manufacturing planning and control systems, the BRPS model is serving as a benchmark for establishing the required functionalism and data relationships needed for the software. Currently, procedures based on established policies and the software tools are being deployed at each of the AT&T factories.

The status of implementation is different for each factory because of differences in manufacturing processes and systems that were in place when BRPS implementation began.

Class A Performance

The overall goal of the BRPS project is to help AT&T to ensure that manufacturing operations profitably produce high-quality goods and services at competitive market prices. In order for each factory to monitor its progress toward this goal, a set of uniform criteria/indices has been established which is applicable to all factories and which reflects the quality of BRPS-related operations at each factory. The set of quality indices, which has become known as Class A Control Indices, includes standards of accuracy for key data and standards of performance for key operations/processes. (See Table II for the list of nine indices and their associated standards.) The indices are based on a point-score system (see Table III) that yields an A, B, C, or D performance/quality designation on monthly intervals. Factories can monitor their performance against individual indices and can get an overall factory-level performance of A, B, C, or D.

Professionalism

A key element in BRPS implementation has been the upgrading of the professional capabilities of employees engaged in BRPS-related jobs. Business Resources Planning has been added as a new major field of work to the Professional Administration Employee (PAE) plan. Qualifications for these jobs are consistent with professional standards for mastery of the body of knowledge associated with resource planning and control for complex manufacturing operations.

Many employees throughout the company have taken advantage of AT&T-sponsored educational opportunities and have become members of the American Production and Inventory Control Society (APICS). Approximately 500 employees have gone on to study for, and to pass, APICS tests to become professionally certified by APICS in the fields of production and inventory control.

The Future

The BRPS functional model focus is on Manufacturing Resource Planning, which is the effective planning and control of all the resources and activities of manufacturing. New thrusts in the manner in which manufacturing activities are executed within the framework established by the model are now on the horizon—notably just-in-time manufacturing (JIT) and computer integrated manufacturing (CIM). JIT is directed toward elimination of waste by continuously improving quality and productivity. CIM is oriented toward the automation of operations and is a natural follow-on to JIT efforts. "Integration" and simplification of processes are major parts of JIT.

As emerging technologies such as JIT and CIM develop, the nature of the manufacturing environment will evolve and consequently the informational requirements and the underlying manufacturing processes themselves will change. As a result of these environmental modifications, it will be an ongoing task for AT&T to incorporate the new informational requirements into its functional model to provide essential and cohesive direction for future system implementations.

Acknowledgments

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