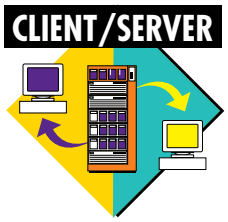

Client/Server Success at IBM

By Eddie Ho and Peter Stoll

The Advanced Workstation Systems Integrated Manufacturing (AWSIM) project is a successful client/server implementation in the industrial environment that uses the RISC System/6000 (RS/6000) to run the IBM Austin manufacturing (MRP) process in a high-availability environment. The AWSIM system is the first large-scale industrial application in IBM manufacturing today that runs on AIX.

In 1994, the MIS team at IBM's RISC System/6000 manufacturing plant in Austin, Texas made the decision to re-engineer the information technology that supported the production and inventory control process. This decision was significant because it represented a commitment to the open systems computing model. It was also a chance to use the RS/6000 in both a client and server role. The decision resulted in Advanced Workstation Systems Integrated Manufacturing (AWSIM), the first large-scale industrial application in IBM manufacturing today that runs on AIX.

The importance of this decision to deploy a client/server computing configuration in an industrial environment can be better understood when viewed against the backdrop of the computer industry in general. The decade of the '90s has brought enormous changes in information technology. The mainframe or host-centric computing model of the previous three decades has given way to a whole new technology called client/server or network-centric computing. This represents a fundamental paradigm shift from the concept of a computer manufacturer designing and building proprietary products that required the customer to become dependent on a single vendor for all hardware, software, and services.

The client/server model is based on the concept of world-wide design standards for hardware and software vendors. The widespread adoption of a standards-based approach to information technology has created the open systems or heterogeneous computing environment. For the first time in the history of the information age, customers can control their computer architecture, select products from various vendors, and expect them to interact together seamlessly.

IBM Austin was the logical place to spearhead the use of client/server technology throughout the various processes that govern the development and manufacture of the RS/6000. IBM Austin uses the RS/6000 in several processes including chip simulation, computer-aided design, and software development and testing. In manufacturing, it uses the RS/6000 in processes such as shop-floor control, preloading of software, and systems testing. It is within this context of a site-wide re-engineering of information technology that IBM Austin decided to convert from a mainframe-based Materials Resource Planning II (MRP II) to a client/server architecture.

Project Scope

The Austin MIS team designed a manufacturing information strategy for the open systems marketplace. This strategy consisted of four objectives. The first was to enable the RS/6000 factory to support the concept of mass customization (shown in Figure 1). Mass customization is the ability to fulfill individual customer sales configurations in high volume. The marketplace now expects an expanding base of options when purchasing computers either one at a time or in large quantities. The Austin team determined the need for new manufacturing (MRP) software to support re-engineering the RS/6000 customer fulfillment process.

Figure 2 shows how a sales configuration is converted into a manufacturing configuration, which in turn draws inventory through the supply pipeline. With this technique, the investment in inventory is tied directly to customer orders, not to a forecast.

The second objective was a just-in-time approach to regulate the flow of inventory within the manufacturing process (Figure 3) as well as the total supply chain from suppliers and trading partners to retail outlets and dealers (Figure 4). The intent is to move inventory only when there is a demand for it further up the inventory pipeline. This just-in-time concept is also described by a Japanese term *kanban*, a signaling system control inventory flow. This approach minimizes the investment tied up in parts on the floor or in finished goods. The Austin team considered the need for cascading replenishment signals that flowed from finished goods backward as an integral part of the new manufacturing software.

The third objective was concurrent engineering (Figure 5), the ability to schedule more development and manufacturing tasks to occur in parallel order instead of in sequential order. The whole RS/6000 Division is continuously shrinking the overall cycle time to market for its new products by organizing many process steps that overlap and by deploying information technology that enables workers with instant access to data and to each other. The manufacturing team considered the need for relational database technology for easy access to information and for flexible software that could be quickly and easily modified when the business process demanded it.

The fourth and final strategic objective was to develop solutions for the first three objectives within the framework of an integrated client/server architecture operating in a network-centric environment. The manufacturing team narrowed their search for hardware, software, and NetWare® solutions that were compatible with the open systems computing model to the RS/6000 products that were designed and built in Austin.

The Business Perspective

The AWSIM system is a totally integrated manufacturing solution for logistics control and customer fulfillment. The AWSIM system has enabled the factory to attain its first key challenge: build-to-order processing. The system helped the factory open new marketing channels by providing a robust sales order-entry and product configuration module that is tied directly to the shop floor control module. This new function allows the Austin facility to compete in the fast-growing computer catalogue telemarketing industry.

The sales order creates a unique configuration of a base computer model with optional memory upgrades, special cards, preloaded software, and peripheral gear such as keyboards, monitors, and CD-ROMs. This configuration is converted into an umbrella shop order with

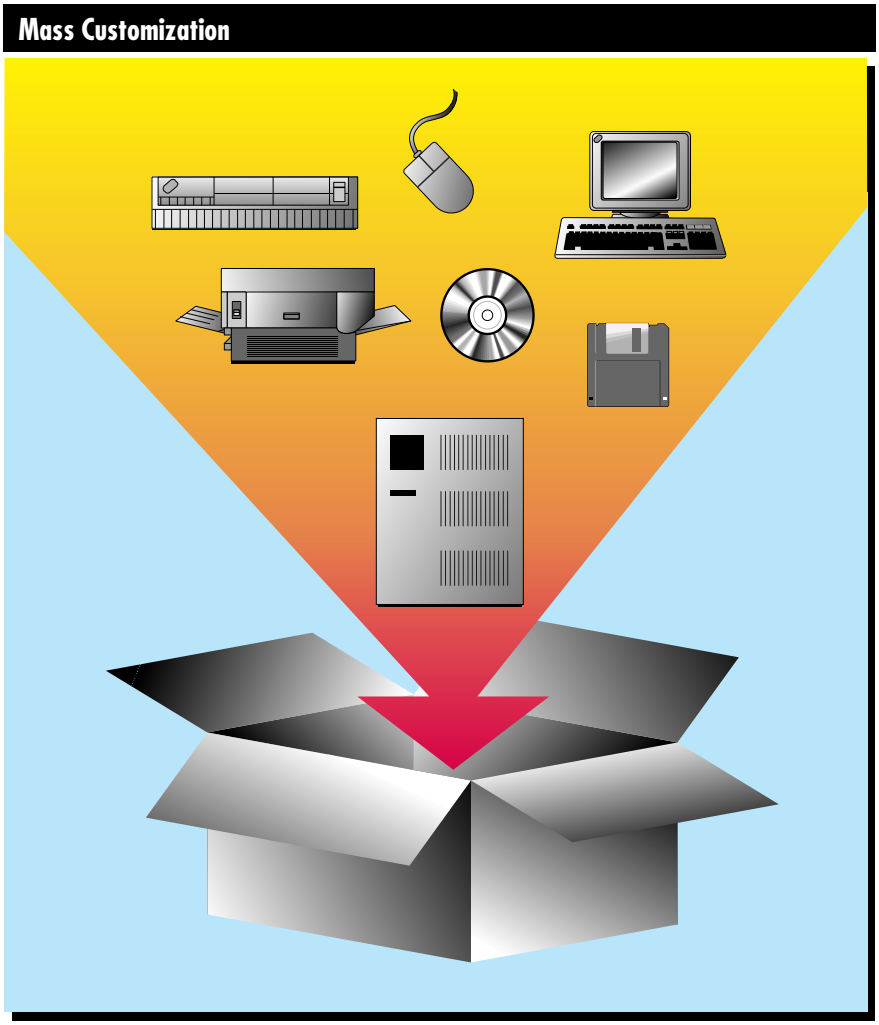

Figure 1. Customized configurations built to order—options, choices, selections

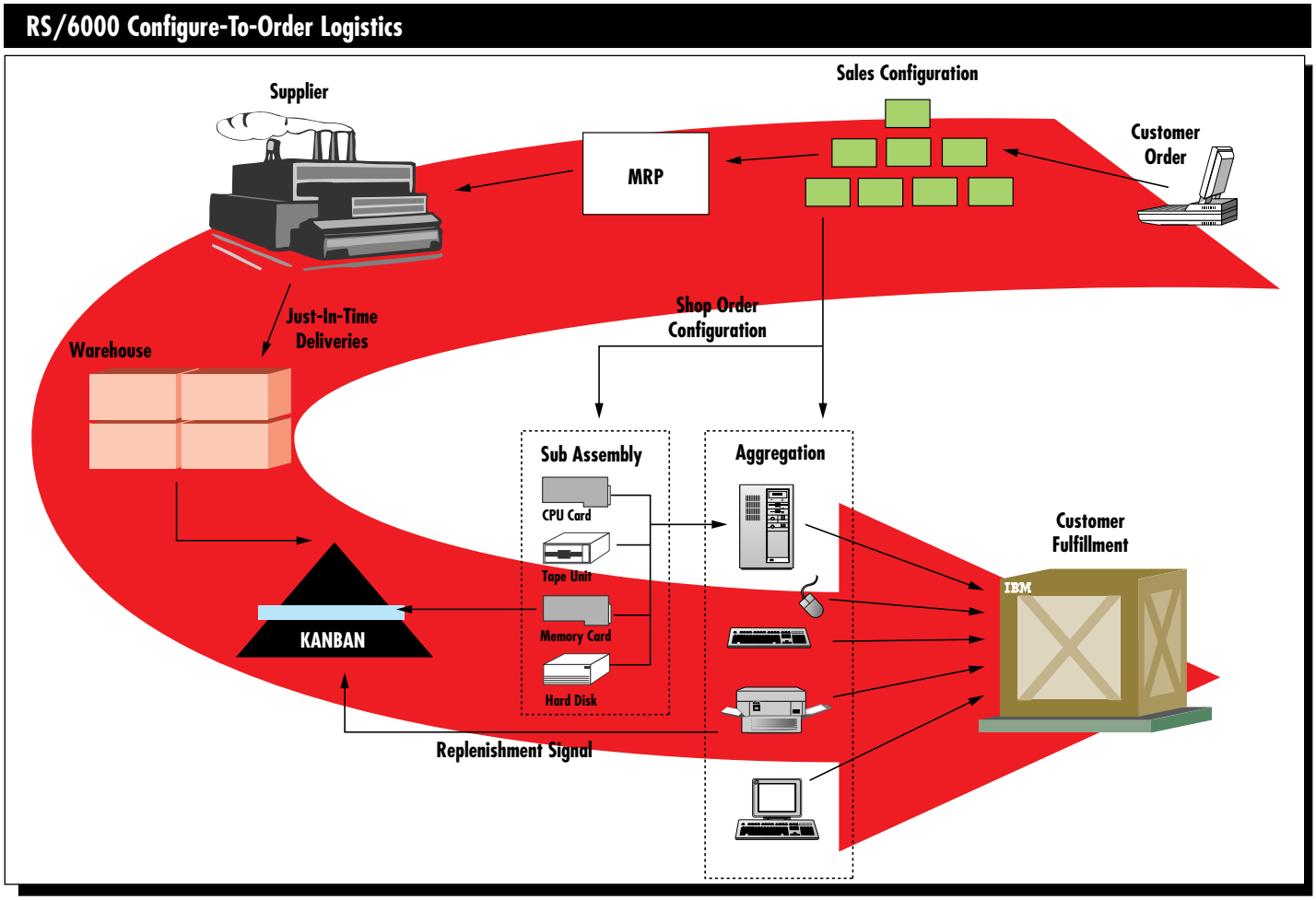

Figure 2. Converting a customer order into a manufacturing configuration

nested shop orders for subassemblies, components, and accessory kits. The AWSIM software is an example of how state-of-the-art information technology can facilitate the business goal of reducing the overall fulfillment cycle—from receiving the order to shipping to the customer.

The second key challenge for the AWSIM team was to implement a just-in-time strategy for inventory control throughout the factory and to the suppliers. The key design point was the concept of replenishment triggers that fire whenever the inventory buffer or kanban is depleted at the manufacturing or final packaging workstations. As the operator installs a subassembly (hard file or tape drive) into the computer chassis, a bar-code reader sends a transaction to the server to fire the replenishment trigger to the warehouse. This restocks the line based on the minimum/maximum rules governing that individual inventory item. The Warehouse Management module receives the inventory "pick" request and automatically determines the specific bin location in the warehouse from which to pick the parts. Whenever the warehouse inventory falls below a predetermined minimum level, the AWSIM system automatically sends an electronic replenishment message to the appropriate supplier.

The Austin MIS team has successfully implemented a client/server solution that represents the cornerstone of their vision for the factory of the future. The team developed a statement of requirements based on management's direction to move the plant toward a customer-based fulfillment process. The AWSIM system supports the build-to-order strategy that is quickly becoming the industry norm for computer manufacturing. The ability to configure an order, create a real-time quote, calculate a promised delivery date, and do an instant credit check—all within a five minute phone call—are just a few of the

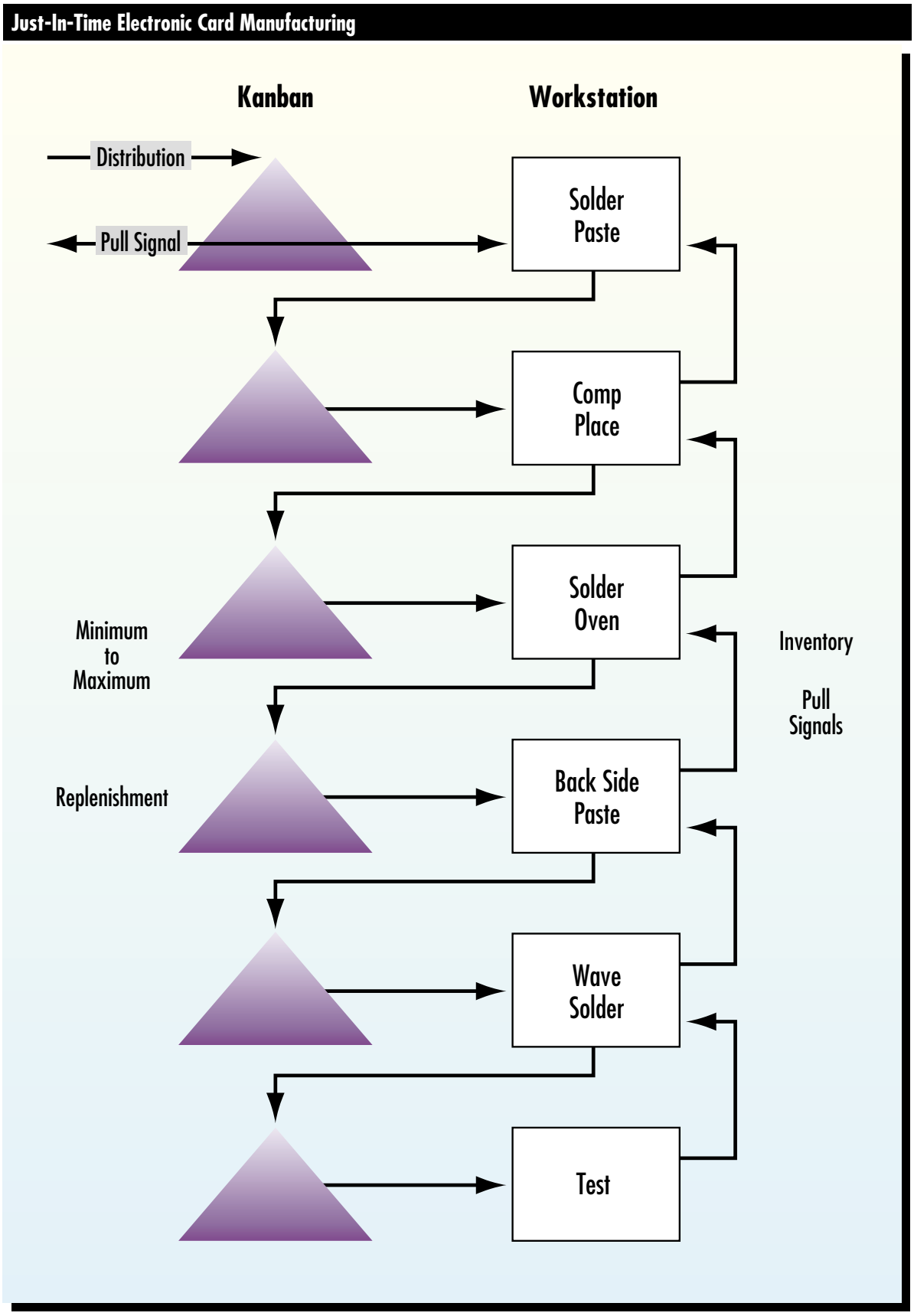

Figure 3. Regulating inventory flow within manufacturing

specialized requirements needed by the modern computer factory to compete in the competitive computer catalogue market.

The Technical Perspective

The AWSIM system is a hybrid version of CIIM 9.0 from Avalon Software Company. AWSIM has been modified to meet the unique demands of the Austin RS/6000 manufacturing and inventory control process. The team recognized that the business needed flexible software that was easy to change when the business demanded it; the older software is generally more rigid and more costly to modify. Avalon Software is written in C using SQL, the standards-based language used by relational database products. This technology decision became one of the critical success factors for the project because new function could be quickly developed on top of the base software package as new requirements arose.

The choice of database products was another key consideration. The open systems marketplace has many excellent database products. The key requirement for Austin was a relational database that performed in a high volume, online transaction environment and delivered subsecond response time.

The team chose the Sybase® relational database management system, which uses performance optimizing techniques intended to focus most real-time processing inside the database, thus minimizing network traffic. The main concepts are stored procedures and triggers. Stored procedures are mini-programs that are preparsed and precompiled to run with minimum overhead from the operating system. The stored procedures are connected by triggers that fire in a predetermined sequence based on the individual transaction.

Client/server technology is designed around the concept of "request and response." The client computer is attached to the network and sends requests for information and/or action to an array of servers also attached to the network. The server is an individual repository of specialized information that sends back a tailored response to the client's request. Client/server is a version of the distributed computing environment that has moved the information age to a new plateau. With this technology, the end user equipped with a workstation can access information across the network from multiple servers and synthesize the data into knowledge at the desktop.

The client and server machines are attached to a 16 Mbit Token-Ring LAN. The whole IBM Austin campus is being retrofitted with 16 MB LANs attached to a 100 MB fiber-optic backbone. The site has deployed router and hub technology for network connectivity and has standardized on TCP/IP as the network protocol.

The hardware solution for the AWSIM database server is a pair of Model 990 RS/6000s. The primary server is backed up by a secondary server in case the primary machine goes down. The software that keeps the two servers operating in tandem is High Availability Clustered Multiprocessing (HACMP). The feature controls the interaction of the two servers and automatically transfers control to the backup when called upon to do so.

In addition to the redundant hardware strategy, the AWSIM system uses Sybase's Replication feature that controls the data mirroring process between the primary and secondary servers. Every transaction that updates

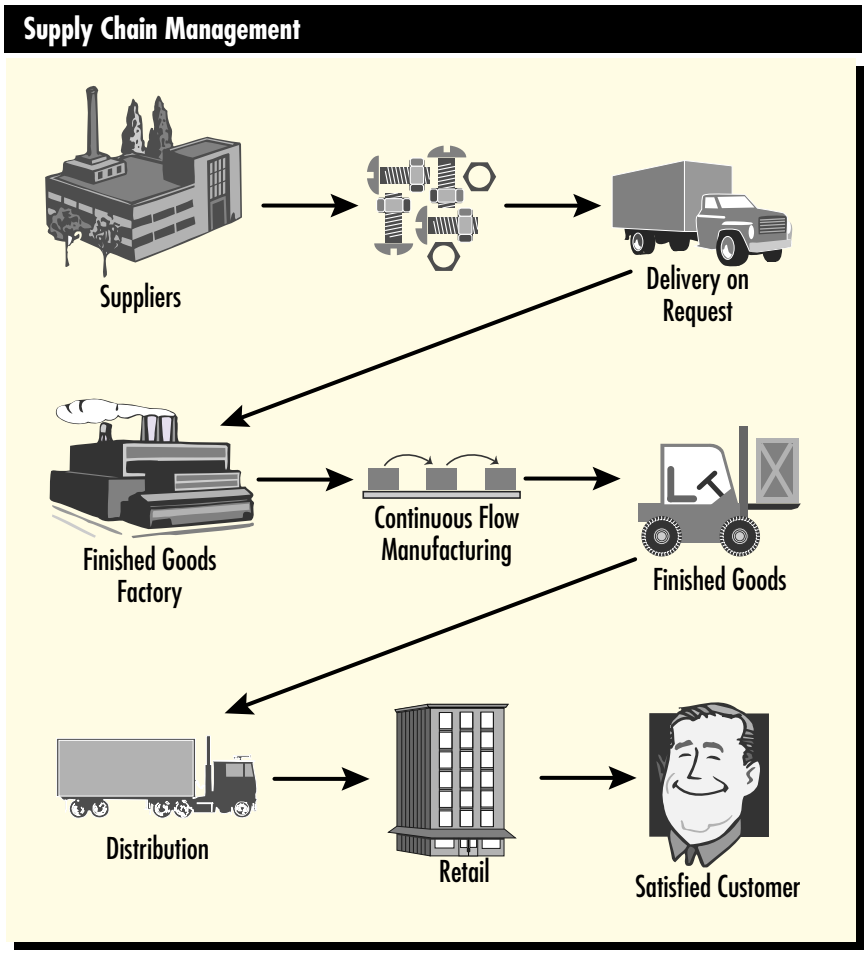

Figure 4. Supply chain management

the primary database is copied to the secondary in order to maintain data redundancy between the two environments. The secondary server, which is also used for ad hoc queries by the end users, helps to reduce the load on the production machine.

Critical Success Factors

The two key challenges to the success of the AWSIM project were scope and skills. The critical factor that contributed most to the successful implementation of the AWSIM system was the team's ability to stay focused on the business requirements and to draw together all the appropriate skills required to support the business and technical considerations.

The AWSIM project required two distinct skill groups. The first group was the business process analysts who mapped out those transactions needed by the user community to do their jobs. For example, the procurement buyer must be able to process a quote from a series of vendors and place a purchase order for the vendor with the lowest price and highest quality. The AWSIM system needed the corresponding transactions to support the buyer's business process. The business analysts wrote the programming specification for the AWSIM development team to follow.

The technical team was the second skill group. This team was further subdivided into internal program designers, development programmers, and system administrators. The nature of client/server or open systems technology is the interoperability of many products within a distributed environment. Accordingly, the AWSIM project required a variety of diverse and specialized computer skills to assist in managing.

The internal design engineering and development programming was done primarily by specially trained staff from third-party software vendors skilled in the native fourth-generation language of Sybase. Their programming proficiency significantly contributed to the rapid rollout of new code whenever the need for functional enhancement arose. An IBM product, Configuration Management and Version Control (CMVC) was the software library and change control tool used to manage the many versions of the software as it progressed through the development and test phases of the project.

The other AIX, security, database, network, and test skills were assembled from various organizations within Austin. The infrastructure team was responsible for keeping the system up all day, ensuring speedy response time, and managing a systems environment that changed continuously.

Figure 5. Concurrent engineering

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