

Production Planning and Control

ENTERPRISE RESOURCE PLANNING

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Understanding Enterprise Resource Planning Systems

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Objectives

- Develop an understanding of how ERP systems improve the effectiveness of information systems in organizations
- Recognize the business benefits of ERP systems
- Understand the history and evolution of ERP

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ERP Market

- One of the fastest growing markets in software industry
- 34.5% of companies with revenues over \$1 billion plan to purchase or upgrade
- \$180 billion in sales in 2002
- Maybe as much as \$1 trillion by 2010

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ERP Systems

- Major investment
 - Cost between \$50,000 and \$100,000,000+
- Variety of business justifications
 - Replace legacy systems
 - Reduce cycle times
 - Lower operating costs
 - Enables better management decisions
 - Real-time
 - On-line

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What is ERP?

- Software tools
- Manages business systems
 - Supply chain, receiving, inventory, customer orders, production planning, shipping, accounting, HR
- Allows automation and integration of business processes
- Enables data and information sharing
- Enterprise-wide system
- Introduces “best practices”

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Evolution of ERP

- 1960s: software packages with inventory control
- 1970s: MRP systems
 - Production schedule with materials management
- 1980s: MRPII systems
 - Adds financial accounting system
- 1990s: MRPII
 - Integrated systems for manufacturing execution
- Late 1990s: ERP
 - Integrated manufacturing with supply chain

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Integrated Systems Approach

- Common set of applications
- Usually requires re-engineering business processes
 - Better alignment
- Limited customization
 - Easier upgrades
- Overcomes inefficiencies of independent systems
- Integrated data supports multiple business functions

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Before and After ERP: Systems Standpoint

	<i>Before ERP</i>	<i>After ERP</i>
Information systems	Stand-alone systems	Integrated systems
Coordination	Lack of coordination among business functions (e.g., manufacturing and sales)	Supports coordination across business functions
Databases	Non-integrated data; data have different meanings (e.g., customer); inconsistent data definitions	Integrated data; data have the same meaning across multiple functions
Maintenance	Systems are maintained on a piecemeal basis; inconsistencies result; it is costly to maintain separate legacy systems	Uniform maintenance; changes affect multiple systems
Interfaces	Difficult to manage interfaces between systems	Common interfaces across systems
Information	Redundant, inconsistent information	Consistent real-time information (e.g., about customers, vendors)
System architecture	May not be state of the art	Relies on a client-server model
Processes	Incompatible processes	Consistent business processes which are based upon an information model
Applications	Disparate applications (e.g., many different purchasing systems)	Single applications (e.g., a common purchasing system)

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Overall Business Benefits

- Information
 - Maximizes information throughput
 - Provides timely information
 - Integrates information throughout supply chain
- Minimizes response time
- Pushes decision making down to lowest levels
- Reduces costs
- Cuts inventory
- Improves operating performance

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Department Benefits

- Sales
 - Increased efficiency
 - Lower quotes, reduced lead time, improved responsiveness
- Manufacturing
 - Concurrent engineering
 - Faster design and production
- Data Service
 - Accurate customer service history and warranty information
- Accounts Payable
 - Suppliers paid accurately

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Business Benefits of ERP

<i>ERP Performance Outcomes</i>	<i>Examples</i>
Quickened information response time	<ul style="list-style-type: none"> • Responses to customer billing inquiries occurred in real-time as opposed to 15–20 minute response time at IBM Storage Products Company (Jensen and Johnson, 1999)
Increased interaction across the enterprise	<ul style="list-style-type: none"> • Simplification of processes at Boeing (Jensen and Johnson, 1999) • Growth in interfacility coordination at Owens Corning (Palaniwasamy and Frank, 2000) • Real-time access to data across the organization at Diebold (Palaniwasamy and Frank, 2000)
Improved order management/order cycle	<ul style="list-style-type: none"> • 90% reduction in cycle time for quotations from 20 to 2 days at Fujitsu (Jensen and Johnson, 1999) • Faster, more accurate order processing at Valente (Palaniwasamy and Frank, 2000) • Time for checking credit upon receiving an order was reduced from 15–20 minutes to instantaneous at IBM Storage Products Company (Jensen and Johnson, 1999)
Decreased financial close cycle	<ul style="list-style-type: none"> • 50% reduction in financial closing time from 10 days to 5 days at Fujitsu (Jensen and Johnson, 1999)
Improved interaction with customers	<ul style="list-style-type: none"> • Lead times to customers were reduced from 6 weeks to 2 weeks at Par Industries (Bingi, Sharma, and Godla, 1999)
Improved on-time delivery	<ul style="list-style-type: none"> • On-time product delivery rate increased to 90% at Earthgrains (Bingi, Sharma, and Godla, 1999) • Delivery performance improved from 80% on-time to more than 90% on-time at Par Industries (Bingi, Sharma, and Godla, 1999)
Reduced direct operating costs	<ul style="list-style-type: none"> • Operating margins improved from 2.4% to 3.9% at Earthgrains (Bingi, Sharma, and Godla, 1999)
Lowered inventory levels	<ul style="list-style-type: none"> • Inventory levels were reduced significantly at Owens Corning (Palaniwasamy and Frank, 2000) • Lower levels of inventory at Valente (Palaniwasamy and Frank, 2000) • Work-in-process inventory dropped almost 60% at Par Industries (Bingi, Sharma, and Godla, 1999)

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Systems Benefits

- Eliminating legacy systems
 - Reduces incompatible data
 - Can cause fragmentation
- Allows sharing and monitoring of information across organization
- Foundation of eBusiness
 - Back-office functions
- Standardization
- Helps obtain and maintain competitive advantage
- Improved interactions with customers and suppliers

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ERP Modules Supported by Vendors

Function	SAP	Oracle	PeopleSoft
Sales Order Processing	Sales and Distribution (SD)	Marketing Sales Supply Chain	Supply Chain Management
Purchasing	Materials Management (MM)	Procurement	Supplier Relationship Management
Production Planning	Production Planning (PP)	Manufacturing	
Financial Accounting	Financial Accounting (FA)	Financials	Financial Management Systems
Management Accounting	Controlling (CO)		
Human Resources	Human Resources (HR)	Human Resources	Human Capital Management

Source: Vendor Websites

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Design Alternatives

- “Vanilla” implementation
 - Complete vendor package
 - Benefits
 - Total integration across all functional areas
 - Re-engineering of all business processes
 - Deficits
 - Expensive
 - Time-consuming
- Selected ERP modules
 - Benefits
 - Less costly and time-consuming
 - Deficits
 - Lacks total integration of data
 - Limited applicability and use

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Design Alternatives, continued

- Build in-house
 - Benefits
 - Can create system based on its needs
 - Competitors will not have access to similar system
 - Deficits
 - Time- and resource-consuming
 - Expensive
 - Risky
 - May not provide competitive advantage
- Maintain concurrent legacy systems
 - Benefits
 - Familiarity
 - Deficits
 - May be a competitive disadvantage

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Cost-Benefit Analysis

- Net Present Value
 - Time value of money
 - 5-year timeframe for ERP
 - Non-recurring costs:
 - Hardware, software, consulting, training, implementation
 - Recurring expenses:
 - Licenses, maintenance, consulting, teams

Net Present Value of an ERP Project						
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Software	2,420,000					
Software Licenses		220,000	220,000	220,000	220,000	220,000
Hardware	1,850,000					
Consulting	3,000,400					
Training	1,280,000					
Implementation Team	400,000	400,000	400,000	400,000		
Total Costs	8,950,400	620,000	620,000	620,000	220,000	220,000
Savings	0					
Reduced Inventory Costs		2,750,000	2,750,000	2,750,000	2,750,000	2,750,000
Reduced Administrative Costs		1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Intangible Benefits						
Total Savings	0	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000
Net Balance	-8,950,400	3,380,000	3,380,000	3,380,000	3,780,000	3,780,000
DCF Factor	1.000	0.909	0.826	0.751	0.683	0.623
Discounted Bal.	-8,950,400	3,072,420	2,791,800	2,538,300	2,591,740	2,347,300
Cumulative Discounted Bal.	-8,950,400	-5,877,980	-3,086,180	-547,720	2,044,020	4,391,400

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Maintaining Competitive Advantages

- Implement ERP system better than competitors
- Migrate to new versions faster
- Use “vanilla” ERP for core systems and build customized modules for others
- Increase availability of operational data
- Better use of data for analysis

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Challenges

- Realization of benefits
- On-time, on-budget implementations
- Applying multi-stage approach
 - Markus
 - Three phases: project, shakedown, and onward and upward phases
 - Business results not achieved until last phase
 - Parr and Shanks
 - Four phases: planning, re-engineering, design, and configuration and testing phases
 - Benefits not achieved until last two phases
 - Holland and Light
 - Benefits occur after implementation of advanced modules

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Summary

- ERP systems can improve the effectiveness of organizations through automation and integration of business processes
- ERP systems allow data and information sharing across the organization
- Departmental benefits include increased efficiency, faster design and production, and accuracy
- Implementing an ERP system helps the organization obtain and maintain a competitive advantage

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Planning, Design, and Implementation of Enterprise Resource Planning Systems

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Objective

- Understand the information systems development process for enterprise systems, including planning, design, and implementation

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Traditional Systems Development Life Cycle

- Detailed analysis of system using tools and techniques to determine problem areas
 - Process models
 - Data models
- Phases
 - Problem definition
 - Feasibility study
 - Systems analysis
 - Systems design
 - Detailed design
 - Implementation
 - Maintenance

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Information Systems Design: Traditional Approach

Step	Activities	Tools and Techniques
Problem definition	Identify problems with the current system	Interviewing and data collection
Feasibility study	Assess the need for a systems project, including technical, economic, and management feasibility	Preliminary cost analysis
Systems analysis	Undertake a detailed analysis of the current system, including processes, information flow, and work organization	Logical process models—present system; Logical data models—present system; Organization charts (functional hierarchy diagrams)
System design	Development of objectives for the new system; re-engineering of processes and information	Logical process models—proposed system; logical data models—proposed system; organization charts—proposed system
Detailed design	Design of specifications for the proposed system	Program design specifications output design; input design Database design; forms design
Implementation	Software implementation; training end-users; development of reporting systems; design of controls and security	Coding; testing; documentation
Maintenance	Ongoing technical support; ongoing upgrades and enhancements	

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Traditional Systems Development Life Cycle, continued

- Automating current system is counter-productive
 - Inherit old problems and flaws
- Provides opportunity to re-engineer current system
- Create logical database design before details are refined
- Takes too much time
- Uses a great deal of resources
- Expensive

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New Approaches

- Prototyping
 - Models shown to end-users for feedback, guidance
 - Not necessarily faster
- End-user development
 - End-users create information systems using spreadsheets and databases
 - Not effective for large-scale development
- Software packages
 - Economies of scale in development, enhancement, maintenance

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ERP Systems Design Process

- Phases
 - Planning
 - Requirements analysis
 - Design
 - Detailed design
 - Implementation
 - Maintenance

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Planning and Requirements Phases

- Planning
 - Needs assessment
 - Business justification
 - Tangible and intangible benefits
- Requirements analysis
 - Identify business processes to be supported
 - “Best practices” offered by vendors
 - Models of supported functions
 - Checklist of activities and factors

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Design Phase

- Re-engineering business processes to fit software
 - Traditional SDLC defines new business requirements and implements conforming software
- Re-engineering versus customization
 - Re-engineering can disrupt organization
 - Changes in workflow, procedures
 - Customizing
 - Upgrading can be difficult

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Alternative Designs

- “Vanilla”
 - Easy to implement
 - Follow vendor prescribed methodology
 - Employ consultants with specialized vendor expertise
 - Usually on time and on budget implementations
- Customized
 - Time and costs increase
 - Not easily integrated into new version

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Detailed Comparison: Re-engineering vs. Customizing Approach

	Re-engineering Approach	Customizing Approach
Re-engineering business processes	Supports re-engineering processes to fit the software system's best practices	Re-engineering is independent of the tool being implemented (e.g., its models, processes, outputs)
Organizational fit	Works well with minimal organizational change, but extensive re-engineering may disrupt the organization	May disrupt the organization less because software is designed to support current methods of work organization and structure
Evolution	Evolution depends upon vendor upgrades and enhancements to the system	Evolution can support unique user requirements
Timeliness	Software is available and ready to implement	May involve lengthy systems development activities
Cost	Implementation is cost-effective	May involve extensive cost of custom implementation
Requirements	Puts boundaries on the design; designs conform with business models and best practices	Provides greater flexibility for meeting unique requirements; not constrained by the tools' best practices; no boundaries for the design
Competitiveness	Other firms have access to the same design	Do not have to use software to which everyone in the industry has access
Fit	Requirements will be supported by an ERP system	Unique requirements may not be supported by an ERP system
External consulting	More of a turnkey approach, particularly using a vanilla implementation	May entail the expense of much external consulting

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- ## Alternative Designs, continued
- Maintain legacy systems and add ERP modules
 - Support specific functions
 - Cost-effective
 - Organization doesn't get full benefit of ERP
 - Less disruptive
 - Lacks integration
 - Outsourcing
 - External vendor operates
 - ASPs provide on time-sharing basis
 - Depends on reliability and stability of vendor
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Menu of ERP Alternatives

Option	Time	Cost	Advantages	Disadvantages
Vanilla implementation of a single vendor ERP	Moderate	Moderate	Easiest to implement	May forfeit internal systems which provide a strategic advantage
Single-vendor ERP with customization	High	High	Maintains strategic processes	Poses greater risk and higher cost because vendor modifications cannot be easily adopted
In-house with supplementary ERP modules	Moderate	High	Minimizes the extent of change that users have to accept	Higher cost because of maintaining legacy systems and new ERP modules; limited benefits because of lack of integration
ASP	Moderate	Moderate	Provides vendor support and expertise at lower cost	Creates dependence on the provider

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- ## Detailed Design Phase
- Team selects the models, processes, and information to be supported
 - "Best practices" methodology provides models
 - Select applicable business processes
 - Discard inapplicable processes
 - Those processes that do not match the system will serve as foundation for re-engineering
 - Identify any areas not covered as candidates for customization
 - Interactive prototyping
 - Extensive user involvement
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Implementation Strategy (Swedish firms)

Implementation Strategy	Percent
Big bang	42.1
Mini big bang	20.4
Phased by module	17.1
Phased by site	20.4

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- ## Implementation Phase
- Implementation
 - Address configuration issues
 - Data ownership and management
 - Security issues
 - Migrate data
 - Ensure accuracy
 - Build interfaces
 - Documentation review
 - User training
 - Reporting
 - Testing
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Implementation Strategies

- Big bang
 - Cutover approach
 - Rapid
 - Requires many resources
 - Small firms can employ
- Mini big bang
 - Partial vendor implementation
- Phased by module
 - Module-by-module
 - Good for large projects
- Phased by site
 - Location-based implementation

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Case: Response to Request for Proposal for an ERP System

- MIS system
 - Supports major accounting and financial functions
 - Sales order processing, inventory control, accounts payable, accounts receivable, general ledger
 - Multiple legacy systems
 - Redundant data
 - Inconsistent data
 - Queries difficult

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Case: Response to Request for Proposal for an ERP System, continued

- Competitors adopting ERP systems
 - Integrating financial and manufacturing
 - Web-based front ends
 - Order processing, tracking, follow-up
- RFP for ERP system
 - Initially to support accounting, financials
 - Additional support for production, manufacturing
 - Eventual support for sales and marketing, HR, CRM, eBusiness
 - \$1,000,000 budget for system
 - Determination made by five executives, representing different user groups
 - 10 scored criteria
 - Vendor presentations, supplemental materials

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Summary

- Traditional SDLC has been modified by the use of prototyping, end-user developments, and software packages
- ERP systems design process consists of six phases: planning, requirements analysis, design, detailed design, implementation, and maintenance
 - The design phase considers the use of traditional methods, re-engineering, and customization, as well as outsourcing

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ERP Systems: Production and Materials Management

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Objectives

- Examine the production management system in ERP
- Understand the materials management system
- Acknowledge the interrelationships among business processes supporting production and materials management

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Case: Atlantic Manufacturing

- Materials and manufacturing are dealing with inconsistent levels of raw materials and finished products
- Change specifications are not made timely
- Sequential design produces long lead times
- Inadequate information from other divisions
- Lost purchasing requisitions

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Manufacturing Systems Background

- Designed to re-order inventory using re-order point
 - Adapts production to customer orders
 - Increased flexibility, responsiveness, integration
- 60s, 70s, 80s: High-volume production of few products
 - Mainframe-based databases
- Late 80s: Production of new products to meet customers' needs
 - Changeable and flexible
 - Manufacturing Execution Systems provided continuous feedback and control
- 90s: Integration of processes and data produce operational efficiency
 - ERP systems gave total integration, including supply chain

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Problems with Traditional Production Systems

- Lack of integration between divisions in organization
 - Production must be linked to sales to maintain proper inventory levels
- Inaccurate production forecast will create incorrect purchasing decisions
 - Producing either a shortage of or extra raw materials
 - Creating an excess of finished products or shortage
- Excess inventories
 - Impact cash flow and profitability in accounting

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Production Systems

- Objectives
 - Create production plan
 - Acquire raw materials
 - Schedule equipment, facilities, human resources
 - Design products
 - Produce appropriate quantities and expected quality level

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Production Planning and Manufacturing Processes

- Operational-level processes
 - Daily activities
 - Purchasing
 - Acquire correct quantity of raw materials and supplies
 - Receiving
 - Inspection of delivered products and processing
 - Quality control
 - Monitoring of receivables and identification of unacceptable deliveries
 - Monitoring quality of production goods
 - Inventory management
 - Maintains appropriate levels

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Information Systems Support

- Production planning and manufacturing processes
 - Supported by information systems
 - Data collection systems
 - Material management systems
 - BOM systems
 - Inventory management systems
 - Cost accounting systems

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Material Resource Planning

- Processes:
 - Identify stock needed
 - Calculate lead time for stock
 - Determine safety stock levels
 - Assign most cost-effective order quantities
 - Produce accurate purchase orders
- MRP takes inputs from the MPS
- MPS employs sales forecasts to identify products needed

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MRP Vocabulary

MRP	The amount and timing of raw materials orders to support the Master Production Schedule (MPS)
BOM	The recipe of materials needed to make a product
Lead times	The time for the supplier to receive and process the order, and ship it to the manufacturer
Lot sizing	Production quantities
MPS	Master Production Schedule
Gross requirements	Raw materials needed for production
Planned orders	Sufficient raw materials for production

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Just-in-Time Systems

- Ideal production and manufacturing situation
 - Only maintain necessary inventory levels; no excess
 - Requires supplies to be delivered only as needed to meet production schedule
 - EDI or Internet used to place orders
 - Continuous replenishments of raw materials
 - Reduces storage cost and space both pre- and post- production
 - Improved supply chain and value chain management

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Capacity Planning

- Evaluation of production capacity against production goals
 - Requires specific information
 - Creates time-phased plans for product and production area
 - Production scheduling
 - Allocation of specific facilities
 - Estimates human resource needed
- Product design and development is integrated with cost information
 - Allows comparison of alternatives to decrease expenses

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Production Planning and Materials Management Modules

- ERP extends information distribution
 - Supports materials requirement planning, inventory management, capacity planning
- Allows for merging of multiple databases
 - Eliminates paperwork and bottlenecks
 - Decreases design costs, lead time, personnel costs
 - Increases productivity
- Sales forecasts employed to develop production plans
- MPS created through demand management
 - Determines quantities and dates for finished products
- MRP creates efficient, detailed material plan
 - Determines what needs to be ordered and when
 - Creates work orders sent to production
- ERP systems provides integration

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Materials Management Modules

- MES
 - Factory floor information and communication systems
 - Provide feedback on real-time basis
 - Can be front-end combined with back-end applications
- APS systems
 - Business analysis and support
 - Leverage data for decision support
- Data collection
 - Real-time data gathered with mobile phone or Internet-enabled devices
 - Automated data collection

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eBusiness Strategies

- Facilitates communication along supply chain
- B2B
 - Many suppliers available
 - Internet enables quick and easy exchange of information
 - Planning forecasts
 - eMarketplaces allow for aggregation of buyers to improve purchasing power
 - Reduces costs
 - Communities
 - Eliminate traditional supply chains and problems
 - RFPs handled more efficiently

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Featured Article: What ERP Can Offer ABC

- What manufacturing data is used by the managerial accounting module within ERP?
- How is this information used to control costs, to maximize productivity, and to streamline operations?
- How does this data integration support managerial decision making?

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Featured Article: What ERP Can Offer ABC, continued

- Activity-based costing systems
 - Need correct activity cost driver
 - Nonfinancial measures difficult to find in accounting systems
 - Usually not controlled by accounting system
 - Lack process controls
 - Often derived from "back-of-an-envelope" information systems
 - ERP systems and activity cost-driver information
 - Increase availability
 - Increased reliability
 - Allows for integration of multiple systems

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Featured Article: What ERP Can Offer ABC, continued

- SAP's R/3 system
 - Links production planning with materials management
 - Allows establishment of standards
 - Materials handling as process
 - Activity cost driver – "number of pallet moves"
 - Materials handling process attributed to specific product
 - Direct costs can be calculated instead of being considered overhead
 - Bill of services created

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Featured Article: What ERP Can Offer ABC, continued

- Activity-based budgeting
 - Anticipates demand on process
 - Estimates practical capacity
 - Estimates quantity of direct materials and direct costs
 - Can be used to improve processes, determine adjustments
- Collects nonfinancial measures for use as drivers
 - Formal process
 - Built-in controls for reliability
 - High degree of integrity

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Summary

- Traditional production systems offered no integration within the organization
- Most production planning lacks coordination with the organization's manufacturing, particularly at the operational level
- Organizations want material resource planning, JIT systems, and capacity planning
- ERP systems offer both production planning and materials management
 - Facilitating communications along the supply chain
 - Improving e-Business opportunities

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