Role of Information Technology in the Lean Enterprise

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Integrated Enterprise

- Organization
- Processes
- Technology
- INFORMATION

Information is a Key Enabler!
Learning Objectives

- Enterprise Resource Planning
- Product Data Management
- IT as Enabler for Collaborative Business Models
- Enterprise IT issues
Manufacturing Resources Planning (MRP II) Definition

Manufacturing Resources Planning

A method for the effective planning of all resources of a manufacturing company.

Includes: Business Planning
Sales & Operations Planning
Production Planning
MPS/MRP/CRP
Execution Support for Resources and Material
All integrated with Finance

Source: APICS Dictionary
Typical MRP II Diagram

- Production Plan
- Customer Orders
- Master Production Schedule
- Work Centers/Routings
- Materials Requirements Planning
- Item Master/Bill of Material
- Capacity Requirements Planning
- Shop Floor Control
- Inventory
- Purchasing
- Finance Functions

Source: T. Shaw

Deborah Nightingale, MIT © 2002
Typical Organization Chart vs. MRP II

CEO

Sales & Marketing
Human Resources
Engineering
Finance
Distribution
Quality
Field Service

Customer Orders → Master Production Schedule → Forecasts
Work Centers/Routings → Materials Requirements Planning → Item Master/Bill of Material
Capacity Requirements Planning → Shop Floor Control
Inventory → Purchasing
Finance Functions

Deborah Nightingale, MIT © 2002  Source: T. Shaw
Enterprise Resources Planning (ERP)

Definition

Enterprise Resources Planning
A method for the effective planning and controlling of ALL these sources needed to take, make, ship and account for customer orders in a manufacturing, distribution or service company.

Includes:
- Typical MRP II Functions
- Sales Force Automation
- Engineering Functions/PDM
- Advanced Manufacturing Function
- Distribution/Logistics Functions
- Quality Functions
- Field Service Functions
- Complete Financial Functions
- Human Resources Functions
- Management Reporting

ERP is a System for the Entire Company - A Global Tightly Integrated Closed-Loop System

(1) Source: APICS Complex Industries Special Interest Group

Deborah Nightingale, MIT © 2002  Source: T. Shaw
Typical ERP Functionality

PROGRAM MANAGEMENT

- Sales & Marketing
- Engineering
- Manufacturing
- Distribution/Logistics
- Human Resources
- Quality
- Finance
- Field Service
Engineering/Product Data Mgt.

- Document Creation, Management & Control
- CAD Interface/ Image Management
- Configuration Management
  - Change Order Creation & Control
  - Revision Control
- Engineering Data Management
- Product Information Management
- Technical Data Management
- Technical Information Management
- Engineering Item Data & BOMs
Manufacturing

- MRPII Functionality
  - MPS, BOM, Routings, MRP, CRP, PAC
- Sales & Operations Planning
- Integrated Production Configuration
- Statistical Inventory Control
- Flexible Product & Job Costing Options
- Kanban/JIT/Flow Manufacturing Support
- Theory of Constraints/Advanced Planning Systems
- Balance Market Demand With Resource Capability
- Develops a Contract Between Manufacturing and Marketing
- A Single Set of Numbers Upon Which to Base Plans and Schedules
- Manages Inventory and Backlog
- Forecasting
Advance Planning and Optimizing System

- Supply Chain Optimization
- Constraint-based multi-location master planning
  - Generation of feasible production plans across multiple plants
- Constraint-based factory level scheduling
  - Generation of feasible schedules (integrated with feasible production plan)
- Optimized distribution and transportation planning
  - Intelligent allocation of inventory through a network
- Purchasing
- Supplier Reliability Analysis
- Distribution Requirements Planning
- Global Transportation Management
- Fleet Management
- Shipping & Receiving
- Import/Export
- Warehouse Management
Human Resources

- Requisition Management
- Applicant Tracking
- Employee Master
- Job Descriptions
- Employee Evaluations
- Training & Certification Management
- Payroll Deduction Accounting
- Benefits Tracking
Quality

- Quality Management Plans
- Quality Specifications/Requirements
- Test/Inspection Results
- Cause and Corrective Action Tracking
- Process/Product Certification
- Statistical Quality Control
- Cost of Quality Reporting
- Equipment & Tool Calibration Mgt
Finance

- Financial Budgets
- General Ledger
- Accounts Payable
- Accounts Receivable
- Payroll
- Fixed Assets
- Cash Management
- Activity Based Costing
- Financial Statements
Field Service

- Installation Management
- As-Maintained BOM
- Warranty Tracking
- Preventative Maintenance Scheduling & Control
- Service Order Planning & Control
Typical ERP Integration

System Wide Elements

Implementation Support Tools

Technology

People / Processes

Source: T. Shaw
Typical ERP Integration

- System Wide Elements
- Project Management & Project Costing (EVM)
- Executive Management Information System
- Work Flow Management
- Multi-Company
- Multi-Currency
- Multi-Lingual
- Multi-Mode
- EDI / Electronic Commerce
- Web Enabled / Internet Communications
- Imaging & Multi-Media
Typical ERP Technology

- Open Systems
- Client/Server
- RDBMS
- Standard APIs
- GUI, both navigation and function
- CASE Tools
- 4GL
- Report Writer/Data Warehouse

People / Processes
There Are Several Reasons Why a Company Will Consider The Implementation of a New Backbone Business System:

- To Improve the Profitability of the Company
- To solve problems of Legacy Systems (Year 2000)
- To Be Able to Cope With New Production Requirements
- To Provide the Architectural Anchor for Rationalization of Acquisitions
- To Provide Interoperability of Its Organizations
- To Provide the Means for Supply Chain Management
Why ERP? (continued)

Reduce Costs - How Will ERP Help?

Enable Reduced Resource Requirements due to:

- Fully Integrated Systems Where Everyone Has Instant Access to the Latest Accurate Information
- One Data Base, Data Is Added Only Once and Used by All
- The System Allows Interoperability of the Internal and External Supply Chain
- On Line (Vs.Batch) System Elements - Data Is There Automatically
- Paperless Systems Allow Efficient On-line approvals
Who is Using and Installing ERP?
America's Most Successful Companies

- 6 out of the top 10 companies
- 7 of the 10 most profitable companies
- 9 of the 10 companies with the highest market value
- 7 of the top 10 **pharmaceutical** companies.
- 7 of the top 10 **computer** companies.
- 7 of the top 10 **petroleum** companies.
- 6 of the top 10 **electronics** companies.
- 8 of the top 10 **chemical** companies.
- 8 of the top 10 **food** companies.
Learning Objectives

- Enterprise Resource Planning
- Product Data Management
- IT as Enabler for Collaborative Business Models
- Enterprise IT issues
PDM Functional Components

- Electronic Vault
- View and Markup
- Work Flow
- Tools and Integration-ware
- Electronic Collaboration

- Configuration Management
- Project Management
- Design Retrieval/Component Libraries
- Scanning and Imaging

Source: T. Shaw, Andersen consulting
An “Industrial Strength” PDM Enables All Participants Involved with Design Intent to Share and Disseminate All Heterogeneous Product Data

Functional Scope

Configuration Management
CAD Integration
Work Flow
Document Vaulting
Document Imaging

Product Data Management (PDM)
Team Data Management (TDM)
Electronic Document Management Systems (EDMS)

Work Group  Enterprise  Inter-enterprise

Source: T. Shaw
PDM Systems View of Functionality

- ECAD
- CSM
- Redline
- MCAD
- Workflow
- Project Management
- CAM
- Configuration Management
- Bill of Material
- Part Master
- Routing
ERP Systems View of Functionality

- Financials
- Quality
- Distribution
- Sales & Marketing
- Human Resources
- MRP II
- Part Master
- Routing
- CSM
- Bill of Material
The Enterprise View of PDM-ERP Functionality

- **Shared Resources**
  - Interoperability Area
  - Management Reporting

- **Design**
  - ECAD
  - MCAD
  - CAM
  - CAE
  - Redline
  - Workflow
  - Project Management
  - PDM
  - Data Vault
  - Part Master
  - Bill of Material
  - Routing
  - Concurrent Engineering
  - Configuration Management
  - CSM

- **Manufacture**
  - ERP
  - MRP II
  - Distribution
  - Human Resources
  - Sales & Marketing
  - Financials
  - Quality

Source: T. Shaw

Deborah Nightingale, MIT © 2002
A Robust PDM Product Interfaces with Most Core Processes and Their Best Practice Implementation

<table>
<thead>
<tr>
<th>Generate Demand</th>
<th>Develop Products/Processes</th>
<th>Fulfill Demand</th>
<th>Support/Service Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Requirements - Local Interpretation</td>
<td>Rapid Cycle Time Execution</td>
<td>Single Bill of Materials</td>
<td>Instantaneous Delivery</td>
</tr>
<tr>
<td>Ultimate Customer Knowledge/ Understanding/ Characterization</td>
<td>Team Based Program/Project Implementation</td>
<td>Integrated Supply Chain</td>
<td>Real Time Services Solutions</td>
</tr>
<tr>
<td>Real Time Market Intelligence</td>
<td>6 s Process Variability</td>
<td>Low Process Variability: Cpk ≥ 1.6</td>
<td>Near Real Time Customer Reaction Assessment</td>
</tr>
<tr>
<td>Solutions Provider</td>
<td>Information Technology Resources Optimization</td>
<td>Just-in-Time Inventory Strategy</td>
<td>Service Actions Data Base</td>
</tr>
<tr>
<td>Customer(s) Chain Life Cycle Characterization</td>
<td>Multi-Discipline, Multi-Function Team Composition</td>
<td>Information Technology Control of Operations</td>
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<tr>
<td>Information Technology Resources Optimization</td>
<td>Integrated Development Processes</td>
<td></td>
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<td></td>
<td>Integrated Product/Process Release</td>
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</table>

**Emerging Best Practices**

- Highly Segmented Market Intelligence
- Full System/Product/Process Modeling/ Simulation
- Real Time Supply Network Integration
- Adaptive Maintenance

Deborah Nightingale, MIT © 2002

Source: T. Shaw
PDM-ERP Will Dictate the Industry’s Future for Integration and Interoperability

- “Single System” versus “Integrated Systems” Solution
- Examples of Each Model Are Successfully Used
- Many Issues Impact Appropriate Decision
  - Scope, focus, objective, business, interoperability

Source: T. Shaw
**Integrated vs. Best of Breed**

### Ferrari Dealership

**2002 Ferrari Roadster**

- 385hp Engine
- Tiptronic Transmission
- Multi Link Transaxle
- Motronic Fuel Injection
- Ferrari Designed Pirelli Tires
  
  *(all components specifically designed to Ferrari specifications)*

### Big Al’s Auto Nirvana

**2002 Best of Breed Ferrari Roadster**

- Corvette 5.0 Liter Engine
- BMW M3 Transmission
- Porsche Transaxle
- Maserati Fuel Injection System
- Mercedes Designed Michelin Tires

**Interfaces and Problem Resolution ??**

- **One Call to your local Ferrari Service Mgr**
- **You are Covered by a Single Warranty**
  
  *Do you call the Service Mgr from….. Corvette, BMW, Porsche, Maserati or Mercedes ??*
1. ERP - a Strategic Enterprise Decision
   - Providing interoperability of systems
   - Integrating supply chain
   - Enabling collaborative partnering

2. Implementation - can’t be outsourced!
   - Core cadre of key process owners
   - Minimum dependence on third party providers

3. Process Re-Engineering
   - Examine existing processes
   - Upgrade to best practices BEFORE implementing ERP

4. Data Conversion
   - Cleansed and accurate population of new data bases in essential
5. Stress Testing
   - Akin to a major system qualification
   - Often short changed since it occurs late in implementation

6. Stabilization of Systems
   - Minimum of 60 days after going live
   - Requires contingency plan for addressing by deliverables

7. Discipline - No cheating allowed!
   - Enterprise management must insist all data/reports come from ERP
   - Significant cultural change

8. Education and training
   - Personnel involved need extensive training
   - At least 10% of implementation budget
9. Implementation Cycle Time
   - Critical to assign outstanding program managers and capable people
   - Up to 100 people at one time
   - Cycle times of 15 months can be achieved

10. Cost -- why are ERP systems so expensive?!!!
   - ERP rolls all or most legacy systems, their licensing costs, maintenance costs, etc. into one systems
   - ROI can be VERY SIGNIFICANT!
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The Vision of Collaborative Business

Everyone Shares Information

“Seamless flow of information”

Source: LEM Overarching Principle

Customers, employees, suppliers and business partners working together as one successful entity.
Personal, Collaborative Solutions on Demand

- **Marketplaces**
  Collaboration hubs

- **Workplaces**
  Portals for personalized, universal, role-based access

- **e-Business Applications**
  e-Commerce, CRM, SCM, Business Intelligence, Logistics, Financials, Human Resources

- **Application Hosting**
  Throughout the solution life cycle
Electronic Marketplaces / Portals / Internet Hubs

**Old World**

- Buying companies
- Suppliers
- Customers
- Employees

**New World**

- Selling companies
- Suppliers
- Customers
- Partners

Deborah Nightingale, MIT © 2002   Source: T. Shaw
Integration Continues to be Key

Needed:
- A plan
- Openness
- Partners’ components
- Cross company synchronization
- Federated Marketplaces
- Common messaging semantics

Strategic nature of integration

<table>
<thead>
<tr>
<th>Time before plan changes</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term fix: Buy/build tactically</td>
<td>Go to the lab:</td>
</tr>
</tbody>
</table>

Hacker’s heaven

A real plan: integration architecture

Source: T. Shaw

Deborah Nightingale, MIT © 2002
New Type of Inter-Enterprise Apps

- Components migrate into marketplaces
- Serving multiple companies at a time
- Hosted
- Ubiquitous
- Personalized
- Self help
- Partner software built-in
- Integrated with back-end
- Scalability, performance, availability and security

A)

B)

- Supply Chain Optimization
  - MRO Procurement
  - Direct Procurement
  - Planning and Optimizing
  - Analysis
- Relationship Management
  - Sales
  - Service
  - Marketing
Evolution of Business Solutions

Enterprise Resource Planning
- Objectives
  - Cost and Efficiency
  - Automation
  - Best-Practice Business Processes
- Integration of business processes
- Process-orientation
- Focus on internal systems

Inter-Enterprise Cooperation
- Objectives
  - Cost and Efficiency
  - Optimization
  - Supply Chain Excellence
- Cooperation across enterprises
- Process-orientation
- Focus on point-to-point linking

Business Collaboration
- Objectives
  - Create Value
  - Flexibility
  - Customer Relationship Management
- Collaboration within business communities
- User-orientation
- Focus on the Internet hub

Source: T. Shaw
Example: SRM Collaboration Application on a Web Services Architecture

Potential Suppliers

Small Suppliers

Large Suppliers

Enterprise Systems

DoD

A&D

portlet-based interaction

exchange-based integration

Source: SAP Group
Web Services Architecture

Portal Infrastructure
- User-centric collaboration
- Unification of underlying sources for seamless navigation
- Device independent presentation technology

Web Application Server
- Web services provision
- Open standards-based connectivity through native Web technology
- Platform independent infrastructure

Exchange Infrastructure
- Process-centric collaboration
- Common business process semantics for seamless integration
- Application-independent business process collaboration

* Example mySAP Technology

Deborah Nightingale, MIT © 2002  Source: SAP Group
Learning Objectives

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ERP systems are being implemented in companies of all sizes.

ERP is generally viewed as a business solution, not an IT solution.

Results on cost reduction for IT operations are mixed.

A single ERP system does not provide end-to-end solution - most companies use systems for specialized functionalities or decision-making processes.

ERP simplifies and standardizes systems across the firm.

ERP systems are very stable, able to handle large transaction processing.

ERP systems significantly improve data availability and quality.

Most companies are pleased with their ERP systems.

1. Address process
   - Simplify/eliminate waste
   - Determine “best practice”
   - Standardize across enterprise

2. Determine enterprise processes information requirements

3. Integrate information using ERP/PDM systems

4. Implement across extended enterprise
   - Supplier
   - Partner
   - e-commerce/e-business