tions. Now, with the emergence of object and component-based solutions, almost every computerized organization will sooner or later be using client software which has incorporated object/component solutions that must be linked with other object/components, even with those which are outsourced.

EAI – ENTERPRISE APPLICATIONS INTEGRATION

Integrating information across the enterprise should be at the top of a Chief Information Officer's (CIO) agenda. The information integration goal should be the linkage among business units, applications, data architectures, computer platforms, network topologies, websites, suppliers, customers, etc. An integration strategy can send a company one step forward or two steps backward.

EAI focuses on solving the integration of multiple applications that were independently developed within the enterprise, may use incompatible information technology, and may remain independently managed. For example, SAP applications can be integrated with Peoplesoft applications that are used in different locations, including different countries. EAI aims at the linkage between different application semantics in order to move information seamlessly between systems in short time frames. For instance, within a short transaction, information exchange takes place to support a discrete event, such as the addition of a customer in one application while automatically updating another.

EAI requires layers of data transformation, metadata administration, software adapters and connectors, network connectivity, and integration administration. The EAI integration scenario is about how information is updated between sources and targets within a given organization.

In an average corporation there are about 50 applications developed internally, installed by ERP software or delivered by the third-party, that should be integrated. Major ERP vendors publish application programming interface (API) to enable connectivity with the third-party applications.

The integration between two applications typically occurs at several levels concurrently. Table 7-3 illustrates seven different levels of integration; each level based on services provided by the lower levels.

In the industrial practice of applying EAI one can recognize four levels of possible solutions delivery:

Table 7-3: Layers of EAI

BUSINESS INTEGRATION	**Business Process Development** Business process design/modeling, real-time decision support, state management
APPLICATION INTEGRATION	**Business Event Processing** Automatic event notification, flow control, content routing, transactional integrity
	Application Content Transformation Format translation, data semantics, validation, prebuilt templates
APPLICATION CONNECTIVITY	**Application Bridges and Gateways** For legacy Web, database, and packaged applications
	Application Interaction Style Publish/subscribe, publish/reply, file transfer, request/reply, conversational
	Message Handling Services Queuing, security, message management, administration
	Basic Communications Point-to-point, reliable broadcast, IP multicast, IIOP/ORB, database, Web, 3270 SNA

Source: NASG, 1999

1. The Custom Development Level – involves the implementation of seven layers' requirements by a special project.

2. The Middleware Toolkit Level – is based on the application of a classic packaged middleware, such as RPC's (Remote Procedure Call), message-oriented middleware (MOM), and transaction processing (TP) monitors. These packages support some housekeeping details.

3. EAI Middleware – are built of tools called adapters for custom developed software. For instance, the adapter can integrate a business process of order entry (in software X) with an e-commerce order form (software Y). This approach led to the creation of CORBA (Common Object Request Broker Architecture) specification, supported by Sun Microsystems. Based on CORBA, Active Software, Inc. provides a toolkit to integrate CRM systems with ERP systems.

4. Vendor-Supplied Solutions – the whole set of applications delivered by a given vendor is integrated by the vendor, so the third-party EAI software is not necessary. For example, the Open Application Group Inc. (OAGI) was founded in 1995 by ERP vendors to promote *intra/inter* vendor packages integration solutions.

The Gartner Group, a market research firm based in Stamford, Conn., estimates that 60% to 65% of the money spent on application integration today goes toward maintenance. This is because traditional point-to-point application integration methods cannot keep up with the speed at which information processing requirements change across the enterprise. Acquisitions, mergers, technology updates and changes in management are regular occurrences that must be accommodated by EII. As the number of applications and complexity of internal data routing requirements increase, maintaining multiple point-to-point interfaces becomes harder. Information flow becomes sluggish and unpredictable, and changing or adding anything becomes a major development effort.

WORKFLOW-DRIVEN INTEGRATION

Workflow systems automate business processes from start to finish, managing the pass of information from one participant to another for action, according to a set of rules. The main task of a workflow system is tracking the status of each activity of the process that is triggered by the transferred information as it moves through an organization.

At the end of 2000, workflow systems fell into two categories:

1. **Collaborative workflow system** – takes place in project-oriented processes, where the centralized system allows co-workers from different departments to work on the same e-documents. The leading vendors in this segment are Lotus, JetForm, FileNet, and Action Technologies.

2. **Production workflow systems** – are applied in transaction processing systems, where the control of the whole transaction processing is the key for the successful and fast conclusion. For instance, a fast decision about a loan application (passing or rather "flowing" through many PC's desk computers whose users-officers "approve," "disapprove," or are "uncertain," according to established rules of the system's digital expert subsystem) is a key concern for a bank or the fast processing of a claim is a key apprehension for an insurance company. This system is controlled by a workflow engine (with a GUI interface) which interfaces with a database, recording all the steps taking place in the flow-driven process. FileNet and Staffware are the most important contributors to this type of software.

Workflow systems free co-workers from having to worry about procedures and paperwork. There is no paperwork which is forgotten or may be lost. Therefore many searches, meetings, and disputes can be avoided.

LEGACY SYSTEMS INTEGRATION

Despite the changes triggered by Web technology, large enterprises still process 70% to 80% of their transactions in legacy systems in COBOL-driven software. These systems apply main-frame computers whose shipments continue to increase. However, Internet technology offers completely new possibilities: mobile staff can access relevant information on the road or at home, and project teams can work together across sites and even between companies. In addition, strategic partnerships, performance links and virtual companies can be formed and connected together in internal work. Customers, partners and suppliers can be connected to information relevant to them, and business processes can be "flown" across sites and companies.

These two contradicting situations cannot be tolerated anymore by IT staff. The only noticeable difference between Web-driven transaction processing systems and legacy systems lies in the interface: the former run with a browser, and the browser is thus promoted to a universal client.

The following strategies of integrating legacy systems within the e-enterprise can be recognized:

- Strategy of making a legacy system more user friendly – requires a new user interface, so-called GUI (Graphic User Interface) which is linked with the COBOL code. It improves the use of a legacy system but does not move it into real-time inter-activities by the *front* and *inter-offices*.

- Strategy of extracting key components from legacy systems and incorporating them into EAI's infrastructure, according to rules of CORBA or Enterprise JavaBeans, DCOM, or XML. These standards are designed to allow loosely coupled components to form complete business applications. This strategy allows the integration of legacy systems with ERP, SCM, and CRM systems.

- Strategy of linking Web-driven Java applets and CORBA components with legacy systems. This strategy allows for the use of legacy systems by the *front-office* in real-time.

The integration of legacy systems into the electronic environment should be guided by the following objectives:

1. Minimizing the maintenance cost of systems;

2. Reducing interfaces and redundancies in software which should lead toward higher reliability and manageability of systems;

3. Adding a new value to a business process through better user satisfaction;

4. Improving return on investment in IT system development and operations.

Recognizing these objectives, many IT organizations are now taking an integration-centric approach to deliver "electronized" legacy systems. This means that IT developers are seeking to connect existing systems, building new or reengineering old components to integrate them with new EII.

BPR – BUSINESS PROCESS REENGINEERING

In their book *Reengineering the Corporation* (1993), Michael Hammer and co-author James Champy define a reengineering goal as "achieving dramatic improvements in critical contemporary measures of performance such as cost, quality, service and speed." The basic steps of reengineering are:

1. Define business objectives – reassess your business purpose and reposition for greater market penetration;

2. Analyze existing processes – reconfigurate your work for smoother workflow;

3. Invent new ways to work – reconstruct your jobs to match reality;

4. Implement new processes – for ongoing competitiveness.

Hammer and Champy say that ability to use insight, imagination, and a willingness to challenge all assumptions are key to BPR. In practice, BPR lets

people change not only procedures but their rules. In effect, they may change not only rules of a given process but of the entire business.

Reengineering in the 1990's inspired executives and managers in thousands of companies to start rethinking and redesigning such basic business practices as customer service, order fulfillment, product development, etc. For example:

- Ford Motor Company found that it employed 100 times more people in its accounts payable department than smaller Mazda. After reengineering the process, the company cut through the territory of accountants, purchasing department staff, and warehouse receiving clerks, and reordered them. Now, a receiving clerk at Ford checks the database for the order and delivery compatibility and quality and if every thing is right, the computer sends a payment to a supplier, even without its invoice. About 500 workers were moved to other jobs, saving on cost.

- IBM Credit, the organization that finances computers, software, and service sold by IBM, learned that the actual work required to process a new customer could be completed in only 90 minutes, instead of the six days to two weeks it used to take.

The main premise of BPR is based on the reorientation of business procedures from function-driven to process-driven. Whereas the former has roots in the 19th century bureaucracy, when each department had its own internal flow of information, the latter is based on the cross-functional flow of information which supports a given process, for instance order fulfillment. The BPR Model in Figure 7-2 illustrates this change in business practice.

Reengineering approaches defined by Currid (1994) are:

- Streamlining business processes;

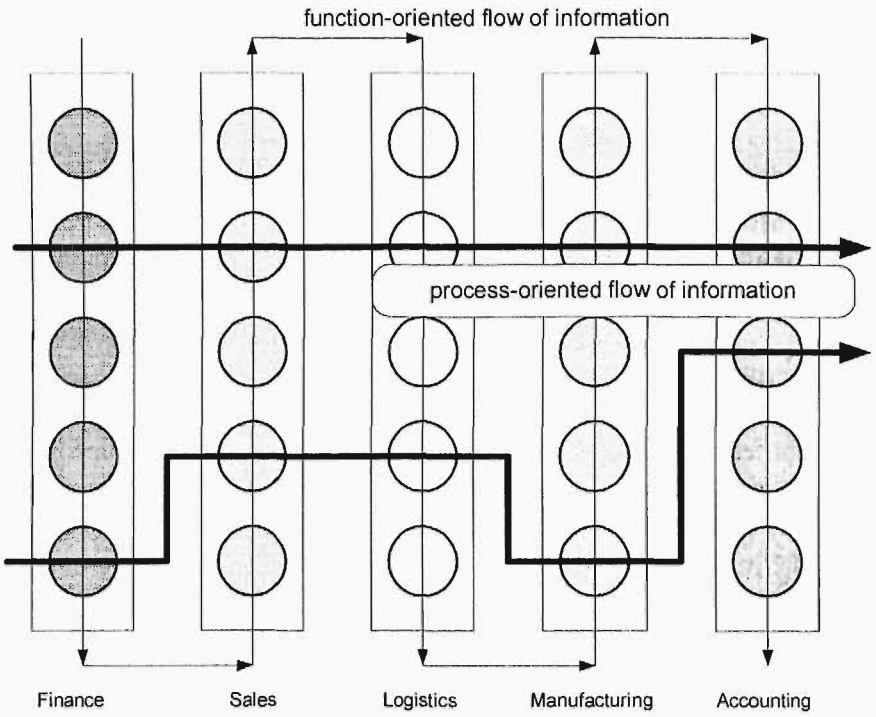
- Integrating business processes;

- Transforming business processes.

The seven reengineering business principles defined by Currid (1994) are:

1. Organize work around results, not tasks;

Figure 7-2: Functions versus Processes



2. Capture data only one time — when it is first created;
3. Allow decision points where work is performed;
4. Incorporate control into information processing;
5. Make people who use a process do the work;
6. Work in parallel instead of sequentially;
7. Treat geographically dispersed resources as one.

The reengineering movement in the 1990's recognized the following issues (Donovan, 1994):

- Global economy changes the business climate and as a result of this many organizations are in crisis. For example, the American airline industry in the first 70 years of their history (1920-1990) generated $3.8 billion in profit. From 1992-94 this industry lost $4.8 billion. In 1994, Sears Roebuck laid off 50,000 employees, closed 100 stores, and sold its insurance and real estate units.

- Business practices turned upside down – in the 1970's major product suppliers (Procter and Gamble, Johnson & Johnson, Unilever) dictated terms to retailers; now Wal-Mart dictates terms to its suppliers.

- Business opportunities are expanding through world-wide privatization, deregulation, globalization, and expansion of internal markets.

- Business and IT are not synchronized and obstacles are caused by mergers, acquisitions, downsizing and layoffs, new consumer-vendor-supplier relationships (mass customization), and low business skills among IT professionals.

- Market expectations are changing – consumers expect better quality products and services, the time-to-market cycle must be shorter, and the profit margin is expected to be higher.

- Dramatic changes in the IT environment have led toward the expanded networking, the client-server architecture, e-commerce (via EDI), tumbling prices and soaring performance, the democratization of IT, adoption of open standards, and so forth.

Despite notable successes at such companies as Bell Atlantic Corp. and Federal Express Corp., many reengineering efforts have fallen short. While countless managers have been persuaded to reengineer, too many have had poor or disastrous results. The main reason that reengineering failed in the 1990's was the fact that operational work cannot be reengineered without changing the way managers do their jobs. Unless the right leadership, teamwork, empowerment, and corporate culture are in place, reengineering cannot succeed.

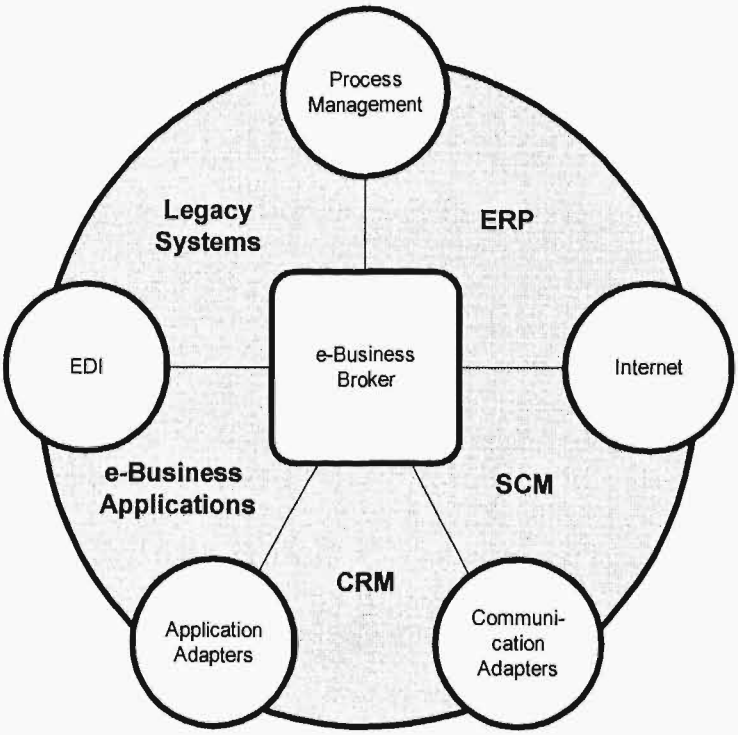
BPI – BUSINESS PROCESS INTEGRATION

EAI typically involves the exchange of information between two applications without regard for business process. BPI, on the other hand, takes into account the overall work flow and the multiple applications required to complete a business process. EIA ensures software compatibility, while BPI applies business rules to operate integrated applications in order to run a business more efficiently.

Steady business transformations and changes drive business process integration. The result is the frequent integration, de-integration, and re-integration at the business process level, which in consequence influence applications integration.

The architecture of the BPI system is proved in Figure 7-3. Its subsystems are described as follows:

Figure 7-3: The Architecture of the BPI System



- **E-Business Broker Subsystem** –exchanges business rules, translated data, messages, and files between business operations of a given business process. It audits and tracks information as it moves within and between enterprises. It also performs notification on events and archives all the data processed.

- **Process Management Subsystem** – allows for the modeling, control, and monitoring of the business process' procedures and policies (rules). This subsystem ensures that a business view is included in an IT solution. This subsystem allows the user to develop a graphic model of a business process driven by business rules, without having programming skills. Based on the business model, the e-Business Broker subsystem will receive specific business rules to execute and control the informated business process. Monitoring tools provide a graphical view of business process operations with ad-hoc reporting.

- **Application Adapters Subsystem** – moves data between legacy and packaged applications (ERP, SCM, CRM) and it is a classic interface which translates different codes among applications.

- **Communication Adapters Subsystem** – moves messages and files securely and reliably within and between enterprises (of suppliers, producers, and distributors), no matter how time-sensitive the information is. This subsystem translates different communication protocols between LAN's, MAN's, WAN's, and GAN's at the level of applications.

- **Internet Subsystem** – provides Web technology and transmission services to support BPI operations between enterprises and within an enterprise (Intranet).

- **EDI - Electronic Data Interexchange Subsystem** – supports data transmission through private and public networks that operate outside the Internet environment.

Based on the e-Business Broker Subsystem, BPI replaces static point-to-point integration (EAI) with a flexible infrastructure that can support even the most complicated business process and can accommodate the unpredictable.