The highly competitive nature of the current business environment creates tremendous pressure for global company operations. To survive—and thrive—in these hypercompetitive markets, it is essential for a company to understand rapidly changing business circumstances. Global organizations strive for agility and flexibility in order to cope with rapid changes in both internal and external environments [8]. To rapidly respond to a changing environment, an enterprise must integrate business functions into a single system efficiently utilizing information technology, and share data with third-party vendors and customers.

Enterprise Resource Planning (ERP) has historically focused on integration of internal business functions. Research has begun to focus on linking an organization’s ERP system to the ERP systems of suppliers and buyers. The implementation of ERP also requires a substantial amount of time and financial commitment [6]. As an alternative, or supplemental technology, Enterprise Application Integration (EAI) automates the integration process with less effort than that required with ERP. To some degree, EAI can even incorporate ERP, thus serving to connect ERP systems. Here, we look at ERP and EAI and investigate their values for today’s organizations. Two different approaches are presented and compared: internalization, represented by ERP; and externalization, through the use of EAI.
Enterprise Integration

As the demand for managing information has increased, researchers have focused their efforts on integrating business processes and data. The term enterprise integration (or system integration) reflects the capability to integrate a variety of different system functionalities.

The Evolution of Information Technology. Traditionally, information systems were implemented to support specific functional areas. The database concept, the fundamental technology of decision support systems (DSS), was introduced in the early 1970s. The advancement of information technology enables new forms of organizations, such as the network-based organization, global teams, and virtual organizations. For example, nearly 60% of organizations are implementing global teams [2]. As organizations become more complex and diverse in the global context, it becomes nearly impossible for organizations to implement their global business concepts without enterprise integration.

In the early 1990s, two distinct system integration approaches were developed—ERP and data warehousing—each with different integration purposes. While data warehousing systems focus on informational integration to support decision making, ERP addresses operational integration to support daily operations [6]. EAI emerged in the mid-1990s to make system integration possible with lower costs and less programming. Figure 1 summarizes the development of information systems.

Technical and Behavioral Integration. Enterprise integration should enable organizations to become more agile and flexible. Nagel and Dove [8] explained agility and flexibility as the ability to “continuously monitor market demand; quickly respond by providing new products, services and information; quickly introduce new technologies; and quickly modify business methods.” To achieve agility and flexibility, it is necessary to have both technical and behavioral integration. Integrating software and hardware—the technical integration—is only one aspect of integration [7]. The biggest challenge may be the behavioral integration. Redistribution of roles and responsibilities among members can destroy an organization if it is not properly managed. Change management and transformation of an organization can be very difficult and sensitive issues. Conversely, it can be argued that behavioral integration is critical to the success of enterprise integration. The technical integration can be a success but if the organization is not going to internalize the enterprise system, the entire project is a failure. As such, to achieve the maximum benefit and impact from enterprise integration, we need to have both successful technical and behavioral integration.

Enterprise Resource Planning

Enterprise integration was pioneered with ERP, by offering a system that accomplished the integration of different operational transaction data. ERP is an enterprise-wide software solution designed to streamline the data flow between different functions in an organization. ERP is an industry term for the broad set of activities supported by multi-module application software that assists a manufacturer or other businesses in managing the important parts of the business, including product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service, and tracking orders.

ERP has been a dominant organizational trend since the early 1990s. Analysts stated that 70% of Fortune 1,000 firms currently have or will soon install ERP systems and the ERP market is predicted to expand into the foreseeable future [1]. To implement ERP, most companies must first reengineer their business processes to adopt ERP standard business processes. Such reengineering proved to be a benefit for firms that needed to restructure their business processes or wanted to drop their legacy systems. For other firms, however, the required reengineering made it impossible to implement ERP as their current business scheme was not compatible with the standard required by ERP. Dell Computer Corp., for example, has stated its decentralized management model is not

<table>
<thead>
<tr>
<th>Year</th>
<th>Key Technologies</th>
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<tbody>
<tr>
<td>1960s</td>
<td>Transaction Processing Systems</td>
</tr>
<tr>
<td>1970s</td>
<td>Management Information Systems, Database Management Systems</td>
</tr>
<tr>
<td>1980s</td>
<td>Traditional Decision Support Systems, Group Decision Support Systems</td>
</tr>
<tr>
<td>1990s and beyond</td>
<td>ERP and EAI, Data Warehousing, Internet Applications</td>
</tr>
</tbody>
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Figure 1. The evolution of information technology.
applicable to ERP’s centralized scheme [3].

Initially it was expected the primary benefits of ERP would be realized in production processes such as improved inventory management and faster order processing. Recently, practitioners and researchers have agreed that the real benefits of ERP are its ability to standardize business processes, build accurate, trouble-free databases, and minimize data complexity.

**Approaches to Implementing ERP.** ERP implementation is no easy task. Once started, there is no going back due to the incredible expense of ERP implementation [1]. During the early days of ERP in the mid-1990s, many companies opted to implement ERP either as a “big bang” or in a phased approach [10]. Recently, companies have followed more structured ways of implementing ERP based on their degree of need for integration.

Current ERP implementation approaches have been categorized as comprehensive (favored by multinational companies, and involving a total effort to implement all modules of the ERP package with business process reengineering); vanilla (an approach favored by less-ambitious companies desiring less business process reengineering and requiring ERP functionalities in only one site); and middle-road (an approach that falls between the other two extremes) [10].

Most firms prefer to buy and install ERP applications with little modification. In order to make this possible, organizations must reengineer their business processes prior to initial implementation of ERP. When there is no intention to change an ERP system at the programming level, the technical implementation is called configuration. Some companies, however, prefer to customize ERP to fit into their organization’s existing processes. Due to the necessity for a physical coding process in an ERP system, the cost of customization is significant, and entails a trade-off between convenience, functionality, and customization. According to Forrester Research [4], only 5% of the Fortune 1,000 companies that purchased an ERP application opted to modify the application to match their business processes.

**ERP Trends.** Today’s companies face extreme competition with their existing rivals and other startup businesses. The key to conquering a competitive and rapidly changing environment is agility and flexibility. Do ERP systems give companies a sense of these two promises? Companies have spent huge amounts of resources to have ERP installed. Unfortunately, many ERP systems do not provide tight-fitting software for specific business processes—particularly for small or unique business processes. The generality of functionality is a serious limitation of many ERP systems. Historically, ERP has been a tool of internalization, which required companies to install other systems in addition to ERP for functions such as supply chain management, sales force automation, online purchasing, and data warehousing. ERP vendors are trying to install the aforementioned external modules as well as analytic decision-making functions.

As previously discussed, a prominent and inherent limitation of ERP is its internal focus. This internalization was an advantage years ago, but now has become a disadvantage due to the increasing focus on changes in the external environment. With the advent and expanse of Web technology, it is possible to do business in the cyber-world. The Internet has created new marketing paradigms, and helped companies recognize that customers are the true assets of their business. With the rapid evolution of Web technology, companies cannot avoid the externalization of their business processes to their partners, suppliers, distributors, and customers. ERP vendors are now working to use the popularity of the Internet and Web to their advantage. The use of Extensible Markup Language (XML), with its ability to search and exchange information on the Web, also presents new opportunities. Vendors such as SAP, PeopleSoft, Oracle, and SAP are also building applications to support customer relationship management, supplier relationship management, and supply chain management. In addition, vendors are researching knowledge management applications [9] and embracing mobile business [11].

**Enterprise Application Integration**

In the mid-1990s, a new approach to system integration known as Enterprise Application Integration—EAI—was introduced. The basic concept of EAI is mainly in its externality of enterprise integration with lower costs and less programming using existing applications. EAI is a business computing term for plans, methods, and tools aimed at modernizing, consolidating, and coordinating the overall computer functionality in an enterprise. Typically, an enterprise has existing legacy applications and databases, and wants to continue to use them while adding or migrating to a new set of applications that exploit the Internet, e-commerce, extranet, and other new technologies. EAI may involve developing a totally new outlook of an enterprise’s business and its applications, determining how existing applications fit into the new view, and then devising ways to efficiently reuse what already exists while adding new applications and data.

Previously, integration of different systems required rewriting codes on source and target systems, which in turn, consumed much time and money. Unlike traditional integration, EAI uses special middleware that
serves as a bridge between different applications for system integration. All applications can freely communicate with each other through a common interface layer rather than through point-to-point integration. Thus, EAI eliminates extensive programming. Figure 2 compares the EAI approach with traditional integration.

EAI Implementation Approaches. The premise of EAI is that it allows a business-oriented approach to map business processes rather than technology-driven business process reengineering. The EAI tools provide a framework for linking applications at the business object level. In other words, there is a possibility that functionality will likely increase in the near future, if many companies license technologies from each other. In practice, EAI can be implemented in four different levels:

- Expanding traditional data integration within a common framework.
- Linking business processes and data at the application interface layer.
- Sharing business logic throughout the enterprise at the component level.
- Leveraging the user interface as the basis for integration.

Within the chosen implementation level, five different integration approaches in EAI software topology are identified and summarized in Table 1. Determining the appropriate topology is critical to enable organizations to manage maintenance costs and integration performance.

The EAI approach has been embraced by companies due to its ability to reuse existing computer applications to streamline processes and the relative convenience of configuration (as opposed to the customized reengineering required to implement ERP). Several vendors, including middleware vendors, already support EAI products such as Vitria, Active Software, Software Technology, and CrossWorlds.

Several limitations with EAI implementations have been identified, however, beginning with the situation that EAI implementation involves an extensive long-term investment in design. Although the time required to implement EAI is less than that required for ERP’s business process reengineering phase, it is nonetheless time-consuming work. Secondly, successful EAI implementation requires that there exist strong communication, coordination, and cooperation between information technology and business personnel. While the EAI approach initially slows down the speed of implementation (due to the need to ensure agreement and integration among personnel), overall it can prove to be beneficial as compared to the "push-oriented" ERP implementation (which enforces standard business processes to business personnel first, then requires business personnel to later internalize those processes). Finally, EAI architecture requires business-mapping processes. Because EAI does not use standardized business process like ERP, a critical aspect is the need to combine separate systems’ business processes.

EAI Trends. According to the Enterprise Integration Council, EAI’s benefits include cycle time reductions, cost reductions, and cost containment. Nevertheless, the ultimate goal of EAI proposed by the Enterprise Integration Council is the flexibility or agility that carefully architected integration brings to the enterprise, permitting rapid response to new business opportunities. To achieve this goal, EAI has been extended in many areas such as mainframe enterprise, systems management, application hosting, middleware, process flow, data integration, and application integration. With the experiences and foundations from these areas, EAI now can support new areas such as ERP, e-commerce, m-commerce (wireless communication), and business-to-business interactions.

Internet technology has made many things possible on the network. Many new business models have been created and old models have been transferred to...
the Internet. E-commerce, m-commerce, and business-to-business (B2B) models have many opportunities and drive EAI into the Internet market. Recently coined terms such as Enterprise Business Integration (EBI) and Internet Application Integration (IAI) have been created in the B2B arena. EAI seeks to integrate activities at the business-process level between companies such as procurement, sales order processing, customer relationship management, and supply chain management, by integrating different Web-based technologies including Java, HTML, XML, and others.

**ERP or EAI?**

ERP implementation is push-oriented, as ERP forces an organization to accept standard integrated business processes. ERP also serves as a bottom-up approach since its implementation starts from the elemental business process. Individuals within the organization cannot select their own (internal and unique) business processes for use in the new system, but are instead required to accept the proposed standard business processes from ERP. This push orientation can be expected to generate a significant amount of resistance from members of an organization. The EAI approach, however, is pull-oriented, as it is not based on the adoption of standard business processes. EAI seeks to integrate separate functionalities of an enterprise into a form that is more acceptable to members of the organization. The EAI approach is also designed as a top-down method, due to its business-mapping procedure. Figure 3 illustrates the two different approaches of enterprise integration.

Both approaches consume a huge amount of time to build integrated systems but ERP seems to takes longer to implement. While ERP forces the adoption of standard business processes, EAI enables enterprise integration over business object levels. ERP thereby supports a centralized business strategy while EAI naturally accommodates decentralized business processes. Although EAI still requires time for mapping business processes, there is no tremendous time-consuming work for implementing standard business processes such as ERP software into organizations. Clearly, ERP implementation requires the reengineering of a business process prior to the adoption of ERP; however, EAI implementation enforces business-mapping processes to EAI architecture. Table 2 shows the summary of ERP and EAI characteristics from two different perspectives.

Both ERP and EAI vendors have recognized market needs and have begun adapting their tools. ERP is now incorporating external environment factors, and many EAI products now available allow for the integration of ERP implementations. For example, EAI, also known as ‘Connector,’ has already been developed to connect big ERP applications such as SAP, PeopleSoft, and J.D. Edwards. Depending on the industry and specific functions, EAI could reduce the

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**Table 2. Characteristics of ERP and EAI in technical and behavioral perspectives.**

<table>
<thead>
<tr>
<th>Technical</th>
<th>ERP</th>
<th>EAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of BPR</td>
<td>High/Medium</td>
<td>Medium/Low</td>
</tr>
<tr>
<td>Integration Method</td>
<td>Process Integration</td>
<td>Process Mapping</td>
</tr>
<tr>
<td>Implementation Period</td>
<td>Long</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behavioral</th>
<th>ERP</th>
<th>EAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Resistance</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Business Process</td>
<td>Centralized</td>
<td>Decentralized</td>
</tr>
<tr>
<td>Internalization Period</td>
<td>Long</td>
<td>Short</td>
</tr>
</tbody>
</table>
While ERP forces the adoption of standard business processes, EAI enables enterprise integration over business object levels. ERP thereby supports a centralized business strategy while EAI naturally accommodates decentralized business processes.

Conclusion
True enterprise integration means both technical and behavioral integration. It is not simply integrating different systems, applications, or business processes dispersed across an enterprise. It is integrating structural changes, different behaviors, and various information systems in an enterprise. Enterprise integration is costly and time-consuming; thus management should be cautious in the design of the project.

In terms of enterprise integration, there are two different approaches: internalization and externalization. These two extremes are moving together due to changes prompted by Internet technology. An enterprise can choose between internalization and externalization. It would not matter whether an organization uses the push-oriented bottom-up ERP approach or the pull-oriented top-down EAI approach. Companies are more concerned about the true enterprise integration with standardization of communication and business through the network. Component-based development (CBD) can facilitate enterprise integration [12]. This would enable an enterprise to have agility and flexibility as well as standardization and compatibility through the Internet (allowing for efficient e-commerce, e-business, m-commerce, for example).

Many new technologies have emerged during the period from the early 1990s to the present. With new achievements in information technologies, companies are vulnerable if they do not respond to those technologies in a fast and proper way. Core competencies, however, are nearly always built from understanding the differences and similarities between the ways of doing business and desired new technologies [3]. Often technology appears to lead industries, but it is very important to examine the compatibility of new technology to be implemented and the capability of one’s organization. The same is true in enterprise integration. Organizations should not blindly rush into new technologies. Top management should first strive to understand their business and needs for enterprise integration, and then select a methodology of enterprise integration.

To achieve agility and flexibility in organizations, there should be a greater degree of communication, coordination, and cooperation in human factors as well as information technologies [5]. In this sense, global organizations have implemented the concept of integrating business processes. Enterprise integration is now both the internalization and externalization of organizations, fulfilling the needs of both internal business processes and external customers.

References
5. Fox, M.S. and Gruninger, M. Enterprise modeling. *AI Magazine* 19, 3 (Fall 1998), 109–121.

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