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Enterprise resource planning: Implementation procedures and critical success factors

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Abstract

Enterprise resource planning (ERP) systems are highly complex information systems. The implementation of these systems is a difficult and high cost proposition that places tremendous demands on corporate time and resources. Many ERP implementations have been classified as failures because they did not achieve predetermined corporate goals. This article identifies success factors, software selection steps, and implementation procedures critical to a successful implementation. A case study of a largely successful ERP implementation is presented and discussed in terms of these key factors.

Keywords: Enterprise resource planning; Business process reengineering; Project management; Critical success factors; Implementation procedures

1. Why ERP?

The business environment is dramatically changing. Companies today face the challenge of increasing competition, expanding markets, and rising customer expectations. This increases the pressure on companies to lower total costs in the entire supply chain, shorten throughput times, drastically reduce inventories, expand product choice, provide more reliable delivery dates and better customer service, improve quality, and efficiently coordinate global demand, supply, and production [25].

As the business world moves ever closer to a completely collaborative model and competitors upgrade their capabilities, to remain competitive, organizations must improve their own business practices and procedures. Companies must also increasingly share with their suppliers, distributors, and customers the critical in-house information they once aggressively protected [17]. And functions within the company must upgrade their capability to generate and communicate timely and accurate information. To accomplish these objectives, companies are increasingly turning to enterprise resource planning (ERP) systems.

ERP provides two major benefits that do not exist in non-integrated departmental systems: (1) a unified enterprise view of the business that encompasses all functions and departments; and (2)

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an enterprise database where all business transactions are entered, recorded, processed, monitored, and reported. This unified view increases the requirement for, and the extent of, interdepartmental cooperation and coordination. But it enables companies to achieve their objectives of increased communication and responsiveness to all stakeholders [9].

2. The evolution towards ERP

The focus of manufacturing systems in the 1960's was on inventory control. Companies could afford to keep lots of "just-in-case" inventory on hand to satisfy customer demand and still stay competitive. Consequently, techniques of the day focused on the most efficient way to manage large volumes of inventory. Most software packages (usually customized) were designed to handle inventory based on traditional inventory concepts [23,25].

In the 1970's, it became increasingly clear that companies could no longer afford the luxury of maintaining large quantities of inventory. This led to the introduction of material requirements planning (MRP) systems. MRP represented a huge step forward in the materials planning process. For the first time, using a master production schedule, supported by bill of material files that identified the specific materials needed to produce each finished item, a computer could be used to calculate gross material requirements. Using accurate inventory record files, the available quantity of on-hand or scheduled-to-arrive materials could then be used to determine net material requirements. This then prompted an activity such as placing an order, canceling an existing order, or modifying the timing of existing orders. For the first time in manufacturing, there was a formal mechanism for keeping priorities valid in a changing manufacturing environment. The ability of the planning system to systematically and efficiently schedule all parts was a tremendous step forward for productivity and quality [21,23,25].

Yet, in manufacturing, production priorities and materials planning are only part of the problem. Capacity planning represents an equal challenge. In response, techniques for capacity planning were added to the basic MRP system capabilities. Tools were developed to support the planning of aggregate sales and production levels (sales and operations planning), the development of the specific build schedule (master production scheduling), forecasting, sales planning and customer-order promising (demand management), and high-level resource analysis (rough-cut capacity planning). Scheduling techniques for the factory floor and supplier scheduling were incorporated into the MRP systems. When this occurred, users began to consider their systems as company-wide systems. These developments resulted in the next evolutionary stage that became known as closed-loop MRP [21].

In the 1980's, companies began to take advantage of the increased power and affordability of available technology and were able to couple the movement of inventory with the coincident financial activity. Manufacturing resources planning (MRP II) systems evolved to incorporate the financial accounting system and the financial management system along with the manufacturing and materials management systems. This allowed companies to have a more integrated business system that derived the material and capacity requirements associated with a desired operations plan, allowed input of detailed activities, translated all this to a financial statement, and suggested a course of action to address those items that were not in balance with the desired plan [23].

By the early 1990's, continuing improvements in technology allowed MRP II to be expanded to incorporate all resource planning for the entire enterprise. Areas such as product design, information warehousing, materials planning, capacity planning, communication systems, human resources, finance, and project management could now be included in the plan. Hence, the term, ERP was coined. And ERP can be used not only in manufacturing companies, but in any company that wants to enhance competitiveness by most effectively using all its assets, including information [23,25].

3. The promise and pitfalls of ERP—why the implementation process matters

Enterprise systems appear to be a dream come true. The commercially available software packages promise seamless integration of all information flows in the company—financial and accounting information, human resource information, supply chain information, and customer information. For managers who have struggled, at great expense and with great frustration, with incompatible information systems and inconsistent operating practices, the promise of a quasi "off-the-shelf" solution to the problem of business integration is enticing. Fig. 1 illustrates the scope of an enterprise system.

This list shows some of the many functions supported by an ERP package [9].

Financials
Accounts receivable and payable
Asset accounting
Cash management and forecasting
Cost-element and cost-center accounting
Executive information system
Financial consolidation
General ledger
Product-cost accounting
Profitability analysis
Profit-center accounting
Standard and period-related costing

Human Resources
Human-resource time accounting
Payroll
Personnel planning
Travel expenses

Operations and Logistics
Inventory management
Materials management
Plant maintenance
Production planning
Project management
Purchasing
Quality management
Routing management
Shipping
Vendor evaluation

Sales and Marketing
Order management
Pricing
Sales management
Sales planning

Fig. 1. The scope of an enterprise system.

It is no surprise that business organizations have been beating paths to the doors of enterprise system developers. A successful ERP project can cut the fat out of operating costs, generate more accurate demand forecasts, speed production cycles, and greatly enhance customer service—all of which can save a company millions of dollars over the long run. At Toro Co., ERP, coupled with new warehousing and distribution methods, resulted in annual savings of $10 million due to inventory reduction. Owens Corning claims ERP software helped it save $50 million in logistics, materials management, and sourcing. ERP also resulted in a reduction in inventory because material-management planners had access to more accurate data—such as how much inventory was already in the pipeline—and could do a better job forecasting future demand [29]. ERP systems reportedly also lead to improved cash management, reduction in personnel requirements, and a reduction in overall information technology costs by eliminating redundant information and computer systems [17,29].

In 1997, $10 billion was spent to purchase ERP systems [31]. That figure increases significantly when the associated consultant expenditures are included. A 1999 APICS survey indicated that one-fourth of members considered or planned to purchase a new ERP system or upgrade their old ERP system in the year 2000. That number jumped to 34.5% among companies with annual revenues of $1 billion or more. Boston-based AMR Research predicted that the ERP market would grow at an annual rate of 32% through 2003. AMR concluded that the impetus for this skyrocketing demand would be manufacturers' desire to establish better control over their supply chains [2,3]. Clearly, the economic slowdown experienced through 2001 dampened this projected demand. However, as the economy recovers, the demand for ERP systems should again dramatically increase.

Surprisingly, given the level of investment and length of time needed to implement ERP systems, many companies have proceeded to implement ERP without making any return on investment (ROI) calculations. But, most companies seem to have had good reasons for doing so—some wanted to integrate diverse business units, others wanted to consolidate redundant proprietary information systems, and many implemented ERP systems to solve their year 2000 problems. But the price of securing the benefits of ERP may be high. Not only do ERP systems take a lot of time and money to implement, they can disrupt a company's culture, create extensive training requirements, and even lead to productivity dips and mishandled customer orders that, at least in the short term, can damage the bottom line [29]. Moreover, according to Standish Group research, 90% of ERP implementations end up late or over budget [33].

Although it has been estimated that the payback period for an ERP system typically ranges from one to three years [3], the evidence is mixed. Meta Group recently surveyed 63 companies—ranging in size from $12 million to $43 billion in corporate revenue—to quantify the payback firms realized from their ERP investments. The data indicated that the average implementation cost $10.6 million and took 23 months to complete. In addition, an average of $2.1 million was spent on maintenance over a two-year period. Ultimately, their research indicated that companies showed an average ROI loss of $1.5 million over a six-year period [29].

4. Critical factors for successful ERP implementation

Implementing an ERP system is not an inexpensive or risk-free venture. In fact, 65% of executives believe that ERP systems have at least a moderate chance of hurting their businesses because of the potential for implementation problems [5]. It is therefore worthwhile to examine the factors that, to a great extent, determine whether the implementation will be successful. Numerous authors have identified a variety of factors that can be considered to be critical to the success of an ERP implementation. The most prominent of these are described below.

4.1. Clear understanding of strategic goals

ERP implementations require that key people throughout the organization create a clear, compelling vision of how the company should operate

in order to satisfy customers, empower employees, and facilitate suppliers for the next three to five years. There must also be clear definitions of goals, expectations, and deliverables. Finally, the organization must carefully define why the ERP system is being implemented and what critical business needs the system will address [12,15,24,30].

4.2. Commitment by top management

Successful implementations require strong leadership, commitment, and participation by top management [8,16,21,26]. Since executive level input is critical when analyzing and rethinking existing business processes, the implementation project should have an executive management planning committee that is committed to enterprise integration, understands ERP, fully supports the costs, demands payback, and champions the project. Moreover, the project should be spearheaded by a highly-respected, executive-level project champion [6,12,18].

4.3. Excellent project management

Successful ERP implementation requires that the organization engage in excellent project management. This includes a clear definition of objectives, development of both a work plan and a resource plan, and careful tracking of project progress [8,16,26]. And the project plan should establish aggressive, but achievable, schedules that instill and maintain a sense of urgency [16].

A clear definition of project objectives and a clear plan will help the organization avoid the all-too-common "scope creep" which can strain the ERP budget, jeopardize project progress, and complicate the implementation [8,16,20]. The project scope must be clearly defined at the outset of the project and should identify the modules selected for implementation as well as the affected business processes. If management decides to implement a standardized ERP package without major modifications, this will minimize the need to customize the basic ERP code. This, in turn, will reduce project complexity and help keep the implementation on schedule [26].

4.4. Organizational change management

The existing organizational structure and processes found in most companies are not compatible with the structure, tools, and types of information provided by ERP systems. Even the most flexible ERP system imposes its own logic on a company's strategy, organization, and culture. Thus, implementing an ERP system may force the reengineering of key business processes and/or developing new business processes to support the organization's goals [20]. And redesigned processes require corresponding realignment in organizational control to sustain the effectiveness of the reengineering efforts. This realignment typically impacts most functional areas and many social systems within the organization. The resulting changes may significantly affect organizational structures, policies, processes, and employees.

Unfortunately, many chief executives view ERP as simply a software system and the implementation of ERP as primarily a technological challenge. They do not understand that ERP may fundamentally change the way in which the organization operates. This is one of the problematic issues facing current ERP systems. The ultimate goal should be to improve the business—not to implement software. The implementation should be business driven and directed by business requirements and not the IT department [4,6,20].

Clearly, ERP implementations may trigger profound changes in corporate culture. If people are not properly prepared for the imminent changes, then denial, resistance, and chaos will be predictable consequences of the changes created by the implementation. However, if proper change management techniques are utilized, the company should be prepared to embrace the opportunities provided by the new ERP system—and ERP will make available more information and make attainable more improvements than at first seemed possible. The organization must be flexible enough to take full advantage of these opportunities [6,26].

4.5. A great implementation team

ERP implementation teams should be composed of top-notch people who are chosen for their

skills, past accomplishments, reputation, and flexibility. These people should be entrusted with critical decision making responsibility [6,8,16,20,26]. Management should constantly communicate with the team, but should also enable empowered, rapid decision making [26].

The implementation team is important because it is responsible for creating the initial, detailed project plan or overall schedule for the entire project, assigning responsibilities for various activities and determining due dates. The team also makes sure that all necessary resources will be available as needed.

4.6. Data accuracy

Data accuracy is absolutely required for an ERP system to function properly. Because of the integrated nature of ERP, if someone enters the wrong data, the mistake can have a negative domino effect throughout the entire enterprise. Therefore, educating users on the importance of data accuracy and correct data entry procedures should be a top priority in an ERP implementation [28,29].

ERP systems also require that everyone in the organization must work within the system, not around it. Employees must be convinced that the company is committed to using the new system, will totally changeover to the new system, and will not allow continued use of the old system. To reinforce this commitment, all old and informal systems must be eliminated. If the organization continues to run parallel systems, some employees will continue using the old systems [10].

4.7. Extensive education and training

Education/training is probably the most widely recognized critical success factor, because user understanding and buy-in is essential. ERP implementation requires a critical mass of knowledge to enable people to solve problems within the framework of the system. If the employees do not understand how a system works, they will invent their own processes using those parts of the system they are able to manipulate [6,10,16,23,26].

The full benefits of ERP cannot be realized until end users are using the new system properly. To make end user training successful, the training should start early, preferably well before the implementation begins. Executives often dramatically underestimate the level of education and training necessary to implement an ERP system as well as the associated costs. Top management must be fully committed to spend adequate money on education and end user training and incorporate it as part of the ERP budget. It has been suggested that reserving 10–15% of the total ERP implementation budget for training will give an organization an 80% chance of implementation success [19,32].

All too often, employees are expected to be able to effectively use the new system based only on education and training. Yet, much of the learning process comes from hands-on use under normal operating conditions. Thus, a designated individual (preferably the project leader) should maintain ongoing contact with all system users and monitor the use of, and problems with, the new system. There is also a need for post-implementation training. Periodic meetings of system users can help identify problems with the system and encourage the exchange of information gained through experience and increasing familiarity with the system [12].

4.8. Focused performance measures

Performance measures that assess the impact of the new system must be carefully constructed. Of course, the measures should indicate how the system is performing. But the measures must also be designed so as to encourage the desired behaviors by all functions and individuals. Such measures might include on-time deliveries, gross profit margin, customer order-to-ship time, inventory turns, vendor performance, etc.

Project evaluation measures must be included from the beginning. If system implementation is not tied to compensation, it will not be successful. For example, if all managers will get their raises and bonuses next year even if the system is not implemented, successful implementation is less likely. Management, vendors, the implementation team, and the users must share a clear understanding of the goal. If someone is unable to

achieve agreed-upon objectives, they should either receive the needed assistance or be replaced. When teams reach their assigned goals, rewards should be presented in a very visible way. The project must be closely monitored until the implementation is completed. The system must be forever monitored and measured [10].

Management and other employees often assume that performance will begin to improve as soon as the ERP system becomes operational. Instead, because the new system is complex and difficult to master, organizations must be prepared for the possibility of an initial decline in productivity. As familiarity with the new system increases, improvements will occur. Thus, realistic expectations about performance and time frames must be clearly communicated [14,21].

4.9. Multi-site issues

Multi-site implementations present special concerns. The manner in which these concerns are addressed may play a large role in the ultimate success of the ERP implementation. The desired degree of individual site autonomy may be a critical issue which depends on two factors: (1) the degree of process and product consistency across the remote sites, and (2) the need or desire for centralized control over information, system setup, and usage. One of the objectives of an ERP implementation may be to increase the degree of central control through the implementation of standardized processes. Alternatively, the implementation may be undertaken in order to provide the remote sites with capabilities that allow them to fine tune their processes to their unique situations.

Another complexity in dealing with multi-site implementations is the degree to which the culture of the organization differs between sites. The fundamental issue here is one of corporate standardization versus local optimization. Corporate standardization brings with it simplified interfaces among diverse parts of the organization, ability to move people and products between sites with minimal disruption, and relative ease in consolidating data across the entire organization. On the other hand, local optimization may result in more effective and efficient operation and may reduce costs.

Perhaps the most difficult decision to be made in a multi-site implementation is the question of cutover strategy. The organization must choose between an approach where the implementation takes place simultaneously in all facilities or a phased approach by module, by product line, or by plant with a pilot implementation at one facility. With a large outlay of cash up front for software, hardware, and the project team, the company may want a simultaneous implementation in order to recoup its investment as quickly as possible.

In a multi-site implementation, a phased approach is generally considered to be preferable. This is partly because the success or failure experienced in the first attempt at implementation often decides the fate of the entire project. Thus, the management team can gain momentum by selecting a pilot site that has a high likelihood of success. And if ERP is installed in a phased approach—module by module, department by department, or plant by plant—the lessons learned at early sites can make the implementations at later sites go smoother [1].

5. ERP system selection

An estimated 50–75% of US firms experience some degree of failure in implementing advanced manufacturing technology [7]. Since an ERP system, by its very nature, will impose its own logic on a company's strategy, organization, and culture, it is imperative that the ERP selection decision be conducted with great care. The greatest enterprise system implementation failures seem to occur when the new technology's capabilities and needs are mismatched with the organization's existing business processes and procedures.

Most enterprises can expect to change or significantly upgrade their computer information systems at least every five to seven years. With the rapid development of new technology, the expansion of features and capabilities, and the proliferation of software vendors, there are numerous options for ERP systems. While most ERP packages have

similarities, they also have substantial differences. Most ERP software vendors make assumptions about management philosophy and business practices. Thus, buying an enterprise application/ERP suite means much more than purchasing software—it means buying into the software vendor's view of best practices for many of the company's processes. A company that implements ERP must, for the most part, accept the vendor's assumptions about the company and change existing processes and procedures to conform to them. Therefore, each organization should try to select and implement a system that underscores its unique competitive strengths, while helping to overcome competitive weaknesses [13,14,23]. The ultimate goal should be to improve the business, not to implement software.

When ERP systems are carefully examined, 80–90% of a particular system will be the same across different implementations, but 10–20% will be different and tailored to the specific needs of the enterprise [22]. Therefore, the company must identify its critical business needs and the desired features and characteristics of the selected system. Two distinct methods can be used for system selection. One method is to implement some overall business strategy by focusing on the information technology infrastructure. Some companies, especially large ones, may derive their greatest benefit through the centralization of data and increased control. The other method is to determine the particular features that are required to run a specific business. So some companies, especially small and medium ones, may opt for software that closely matches the specific functions and processes of their business to more easily manage the business, increase efficiency of operations, and reduce costs [12,23].

ERP packages are primarily proprietary systems as opposed to open system architectures. This can limit the flexibility of the enterprise that adopts a particular ERP package. Approaches to process design depend on the enterprise software selected. Standardized processes such as SAP R/3 and PeopleSoft require the adopting firm to adapt its processes to the requirements of the software. SQL and Oracle are more accommodating and allow firms to tailor the software to existing processes [11]. In addition, companies with the necessary expertise can develop their own systems for integration. Developing in-house software can offer the freedom to find creative solutions to integration problems. For example, in 1996, Dell Computer Corporation initially planned to roll out SAP's full R/3 suite, but it balked because Dell executives did not believe that the package could keep up with Dell's extraordinary corporate growth. Instead the company designed a flexible architecture to allow the company to add or subtract applications quickly and select software from a variety of vendors [27].

The importance of the actual software selection process must not be underestimated. The current literature includes some recommended steps and suggestions for the selection process [14,20,21]. Based on the available sources and our own experiences, the authors recommend the following thirteen-step selection process.

1. *Create the vision.* Define the corporate mission, objectives, and strategy. Use cross-functional teams and executive-level input to identify, examine, and rethink existing business processes. This helps to ensure the necessary buy-in of both executive management and the process owners. Clearly define why the ERP system is to be implemented. If multiple plants are involved, the process must include participants from all plants. Once the vision is approved by top management, broadcast the vision to the entire company.
2. *Create a feature/function list.* A team composed of respected individuals who are familiar with the various software packages, company processes, and the industry should be responsible for identifying the features and functions required for the software to effectively support each functional area as well as the overall company vision. Business unit managers must be able to document their current business processes to the project team and to map those processes to the new best practices model from the ERP application.
3. *Create a software candidate list.* The field may be narrowed based on criteria such as the size of the enterprise or industry type. Select only ERP providers that are right for your business.

Talk to existing users, particularly those in your industry, about what they like and dislike about their ERP systems.

4. *Narrow the field to four to six serious candidates.* This can be accomplished by a preliminary analysis of the strengths and weaknesses of each supplier and the "goodness of fit" of the software.
5. *Create the request for proposal (RFP).* The RFP typically contains the feature and function list, which describes how the company wants each department or function to operate and the "outer wrapper," consisting of instructions to the supplier, the terms and conditions, supplier response forms, and so forth.
6. *Review the proposals.* Consider strengths, weaknesses, areas that require more clarification, and areas of doubt for each supplier. Ask for additional information where appropriate.
7. *Select two or three finalists.*
8. *Have the finalists demonstrate their packages.* In order to provide a thorough critique, all key members of the selection team should be present for all demonstrations.
9. *Select the winner.* When companies select their system, price is frequently a major factor. But it is critical not to underemphasize other important criteria such as supplier support, ease of implementation, closeness of fit to the company's business, flexibility when the company's business changes, technological risk, and value (total implemented cost versus total value to the company).
10. *Justify the investment.* Based on the specific ERP software that has been selected, the potential tangible and intangible benefits of the implementation can be compared to the costs. Tangible benefits might include better visibility of future requirements, improved material control, reduced costs, increased productivity, increased on-time deliveries, improved customer service, and the elimination of redundant and contradictory data bases. Intangible benefits might include improved communications, substantially reduced chaos and confusion, and higher morale. Make a formal go or no-go decision on the software; keep the option of choosing "none of the above."
11. *Negotiate the contract.* The company's negotiating position may be influenced by the analysis performed in step 10.
12. *Run a pre-implementation pilot.* The purpose of a pre-implementation pilot is to uncover major surprises, both good and bad, about the software as quickly as possible so as to facilitate the overall implementation.
13. *Validate the justification.* Using all information collected to this point, make a final go, no-go decision on the implementation. In extreme cases, if necessary, reverse the decision to implement ERP, change vendors, or renegotiate the contract.

6. Implementation steps

ERP systems can be complex and difficult to implement, but a structured and disciplined approach can greatly facilitate the implementation. The authors have compiled a list of 11 recommended steps for a successful implementation. These steps have been integrated from several works [14,21–23].

1. *Review the pre-implementation process to date.* Make sure the system selection process has been satisfactorily completed and all factors critical to implementation success are in place.
2. *Install and test any new hardware.* Before attempting to install any software, it is essential to make sure that the hardware is reliable and is running as expected.
3. *Install the software and perform the computer room pilot.* A technical support person from the software supplier will often install the software and run a few tests to make sure it is installed correctly.
4. *Attend system training.* Software training will teach users the keystrokes and transactions required to run the system.
5. *Train on the conference room pilot.* The conference room pilot exercises the systems and tests the users' understanding of the system. The project team creates a skeletal business case test environment which takes the business processes from the beginning, when a customer order is

received, to the end, when the customer order is shipped.

6. *Establish security and necessary permissions.* Once the training phase is finished, during the conference room pilot, begin setting the security and permissions necessary to ensure that everyone has access to the information they need.
7. *Ensure that all data bridges are sufficiently robust and the data are sufficiently accurate.* The data brought across from the old system must be sufficiently accurate for people to start trusting the new system.
8. *Document policies and procedures.* The policy statement is a statement of what is intended to be accomplished; the procedural steps to accomplish that statement may be detailed in a flowchart format.
9. *Bring the entire organization on-line, either in a total cutover or in a phased approach.* In a "cold turkey" approach, the whole company is eventually brought onto the new system. The entire company prepares for the cutover date, which would preferably be during a plant shutdown of one to two weeks. In a phased approach, modules/products/plants are brought on-line sequentially. After the first module/product/plant is live, procedures may be refined and adjusted, then the remaining modules/products/plants are sequentially implemented. The phased approach may allow for improvements to be made during the implementation.
10. *Celebrate.* This can be the most important step. The company has just completed a major project; the celebration recognizes this and clearly demonstrates the importance of the project to the organization.
11. *Improve continually.* The organization can only absorb a limited amount of change during a finite time period. Change is an on-going process; successful companies understand this and encourage their employees to use the system to continue to improve.

7. Why implementations fail

The top three reasons for the failure of IT-related projects, as cited by IT managers surveyed by *Information Week*, were poor planning or poor management (cited by 77%), change in business goals during the project (75%), and lack of business management support (73%). As a result, most IT-related projects fall far short of their potential payback, and 26% are canceled before completion. Moreover, in many of the completed projects, the technology is deployed in a vacuum and users resist it [8].

Langenwalter claims that the percentage of ERP implementations that can be classified as "failures" ranges from 40% to 60% or higher [14]. Ptak defines failure as an implementation that does not achieve the ROI identified in the project approval phase and finds that failure rates are in the range of 60–90% [23].

Based on the concepts presented in this paper, the reasons for failure can be placed into 12 categories [7,8,14,19–21,23,31]. These categories appear in Fig. 2.

8. Case study: ERP implementation at Huck International, Inc.

Huck International, Inc., successfully implemented an ERP system during 1998 and 1999. This case study is a description of their implementation, including an indication of the degree to which they adhered to the critical success factors, system selection guidelines, and implementation procedures described in the first part of this paper.

8.1. Brief history

Huck International, Inc., designs, manufactures, and distributes a wide range of proprietary commercial, industrial, and aerospace fastening systems. At the beginning of the ERP implementation, Huck was comprised of three aerospace fastener plants, two industrial fastener plants, one installation tool manufacturing plant, corporate headquarters, and five international sales and distribution sites. Of the international sites, one also manufactured aerospace fasteners and one manufactured industrial fasteners. Annual sales were about $250 million. During the implementation, acquisitions and consolidations significantly

The reasons why ERP implementations fail can be placed into ten categories.

1. *Strategic goals are not clearly defined.* The organization has not thought through the goals, expectations, and deliverables.
2. *Top management is not committed to the system.* Top management lacks commitment to the system, does not see the profound changes it engenders, and/or does not actively participate in the implementation.
3. *Implementation project management is poor.* The organization underestimates the scope, size, and complexity of the project.
   - Achievable schedules are not developed; realistic expectations are not communicated.
   - There is a mismatch between the business and the ERP system selected.
   - Companies attempt to automate existing redundant or non-value added processes.
4. *The organization is not committed to change.*
   - People have a natural tendency to be comfortable with the status quo and may not see the need for a new system.
   - Employees may fear that the new system will make their jobs more difficult, reduce their importance, or even cost them their jobs.
   - Front line staff may be uncomfortable with the realization that upper management can easily see what they are doing.
5. *A great implementation team is not selected.*
6. *Inadequate education and training results in users that are unable to satisfactorily run the system.*
7. *Data accuracy is not ensured.* Inaccurate data will cause ERP to lose credibility, causing people to ignore the new system, and continue to run the company under the old system.
8. *Performance measures are not adapted to ensure that the organization changes.*
9. *Multi-site issues are not properly resolved.*
10. *Technical difficulties can lead to implementation failures.* These difficulties can include "bugs" in the software, problems interfacing with existing systems, and hardware difficulties.

Fig. 2. Why ERP implementations fail.

changed the company structure. The original twelve sites were consolidated to ten, and an additional ten were added through acquisition. Sales at the end of the process approached $450 million per year.

The legacy system at all Huck North American and European sites was CA/ManMan, a classic mini-computer based MRP II system. ManMan had been in place since 1983 when it replaced a homegrown, IBM-based, centralized data processing system. While some of the smaller sites operated remotely, most sites had their own HP3000 as the standard hardware platform. The system(s) had been upgraded several times, and numerous modifications had been installed. While the base software and company modifications were administered from company headquarters, each site had specific modules that were unique to its business environment. ManMan users were very familiar with the system and its capabilities. The hardware was extremely stable and software at some sites had not been upgraded for several years. Huck sites in Japan and Australia were on unique, local systems.

Although the MRP II system was ancient by IT standards, Huck had implemented an extensive local area network. Most users accessed the main computer through the network and were familiar with windows-based applications. Network-based information sharing was widely used by most key users. For example, all engineering and manufacturing drawings, as well as statistical process control data, were accessed through the network. PC workstations were placed throughout the plant for

easy access to these documents by all shop floor users.

8.2. A clear understanding of strategic goals (Why ERP for Huck?)

Several factors combined to initiate the move to ERP. Y2K incompatibility was a key issue. Multiple upgrades and recreation of site-specific modifications would have been required to become Y2K compliant. The cost in dollars and business disruption would have been significant. Since the base software had not been significantly improved in recent years, the expense and effort would at best achieve no functional improvement. In addition, the business environment was rapidly changing to encourage more intimate business-to-business transactions with key customers, and the old system was not compatible with the newer systems that were being installed in the customer base. Future enhancements to the existing system were not expected, and Huck did not want to maintain in-house information system resources to develop the new capabilities and interfaces that would be required.

8.3. Commitment by top management

Huck's CEO issued a directive that the company would move toward a single information system for all current and future sites. This was strongly supported by top management. However, during the implementation, a realignment of the executive staff somewhat affected the continuity of executive support. But more significantly, the closing of two sites, the acquisition of ten new sites, and unprecedented record sales so distracted top management that appropriate executive level support was somewhat sporadic and certainly less visible than might have been desired. For example, the initial implementation site was designated to absorb one of the two consolidation closings. And, during the critical implementation "go-live" weekend, some of the implementation team members were also required to participate in the physical reorganization of the manufacturing plant to facilitate the relocation of an additional 100 workers and machines displaced by the consolidation. This was a dual disaster waiting to happen. Only the extraordinary dedication, effort, and ability of the implementation team prevented a significant failure in both initiatives.

8.4. Project management and multi-site issues

The new system was expected to replace all current ManMan functions. These included all operations, sales, distribution, and accounting. Payroll and human resources were not included. Although the capability to consolidate financials was desired (and a factor in the final selection), each site was set up as an independent financial entity. The implementation strategy was to develop model processes at the primary site (located in Texas), and rollout to subsequent sites a framework on which to build local processes. This would provide learning curve benefits as well as efficient resource utilization as support personnel could move from site to site as the timeline rolled forward.

As part of the multi-site implementation process, a Project Management Office was established. This function was charged with communication and coordination of resources. One very effective tool was the establishment of an intranet web site for the consolidation of information. The web site contained such things as telephone directories, travel policies, weekly project update reports from all sites, and an issues resolution database. Answers to frequently asked questions and previously solved problems, as well as the current status of in-process resolutions, could be easily accessed. The forward transfer of lessons learned from early implementations to later ones was a major responsibility of the Project Management Office.

The project was divided into phases. Phase I included implementation of the system at the primary site, corporate HQ, and the international locations. The final software selection was made in March 1998; the anticipated go-live at the primary site was January 1, 1999. All seven phase I sites were expected to be live by end of the first quarter of 1999. Due to delays in the justification and approval process, the project was not started until late June, 1998. Target go-live dates were not adjusted because of the strong desire to cut over at

the end of a financial period. Because of the acquisitions and consolidations, the scope of phase I ultimately increased to nine implementations. Phase I was actually completed in July, 1999.

8.5. Managing change

Long before the ERP implementation was undertaken, Huck had developed a company culture that was receptive to change. For several years, the company had embraced a program of monthly "kaizen breakthrough events" in the pursuit of lean manufacturing. These events occupy teams—composed of six to ten shop floor employees, local and corporate executives, customers, and suppliers—who are charged with the analysis, redesign, and implementation of improvements in specific business or manufacturing processes. Teams frequently install, move, or modify equipment, rewrite procedures, change work assignments, set local operations policy, and otherwise make changes as required to achieve their designated goals. In addition, Huck has numerous self-directed, permanent cross-functional teams that are charged with continuous improvement in a variety of areas. Huck was well positioned to implement and accept the changes brought about by the ERP implementation.

8.6. The implementation team

The implementation team was selected from all functional disciplines. At the primary site, twelve of the most capable and knowledgeable people were selected. The expectation was for an average commitment of 50% of the team's time for the six-month anticipated duration of the project. Although the total time estimate was very accurate (actual logged time for the team was 6000 man-hours) the distribution of time required varied greatly. For some team members, a full-time commitment was added to their continuing daily duties and responsibilities. A better approach would have been to assign six multi-discipline individuals committed full time to the project. Additional expertise could have been attained as needed through interviews and temporary assignments to the project team. Totally free of day-to-day interruptions, a smaller team would likely have been more productive.

A major responsibility of the project team was the conference room pilot. A cross-section of products, processes, customers, and various scenarios were created and tested. Several new processes were evaluated and accepted or rejected. One particularly rigorous test was a series of complete order-to-cash process flows, where the transaction values were manually calculated in advance and the system results validated for accuracy and completeness. The conference room pilot was one place where the pressures of team members' daily responsibilities adversely impacted the quality of the project. In those functional areas that were represented by project team members that had sufficient time available to explore alternate process strategies during the conference room pilot, significant improvements were generated. But in those functional areas represented by team members that had inadequate time to dedicate to the pilot, the typical result was a substandard replication of the old legacy system processes.

8.7. Data accuracy

Once the pilot was validated, the conversion process was tested. Moving data is easy. Validating that the data are accurate and complete is extremely difficult. (One consultant working with Huck confided that, in a previous position as a user, his company's conversion strategy did not include a reconciliation of total customer order line items. Orders were "lost" in conversion and only discovered through customer complaints for non-delivery.) Huck's conversion strategy included numerous checks for line counts of sales orders, purchase orders, work orders, and other assorted categories of dynamic data.

Inventory revaluation is a huge concern when cost accounting systems are changed. In the case of an ERP implementation, this is unavoidable (unless the cost accounting process of the legacy system is somehow duplicated). To avoid any significant revaluation issues, a process was developed to export real-time data from the converted database and compare the cost variances. The process was a relatively simple export from

the legacy system of both dynamic and static data such as on hand balances, standard or average cost (Huck used both depending on the item), annual usage, average inventory, and so forth. This data was loaded into a spreadsheet with the projected cost as calculated by the new ERP system. From this spreadsheet database, numerous detailed and summary analyses were conducted. Item-to-item costs were sorted by variance, and all major discrepancies were resolved. The total inventory revaluation was less than 1%. The process was also very effective in screening and testing practice runs of the conversion procedures for accuracy and completeness.

Stress tests were conducted on the system as soon as a converted database was available. The project team simulated full business operations by initiating multiple processes and performing system-intense procedures while simultaneously running CPU-intense utilities. Although no system problems were discovered during these tests, a major system response issue arose at cutover. The quality management module, which had worked flawlessly in the pilot, displayed response times of several minutes. This subsystem dictated that no inventory moves or transactions could occur until quality assurance had "signed off" on the transaction. The slow response time totally froze operations! Because of the extreme urgency of avoiding a complete business shutdown, there was no time to properly investigate and resolve the underlying problems. To avert disaster, the entire subsystem was uninstalled item by item and order by order.

8.8. Education and training

Education and training were conducted by the implementation team. Step-by-step instructions were created during the pilot. The instructions included detailed screen shots with valid company data in all fields. These were imported to Word documents, which included instructions and written procedures. Training materials were available in hard copy for classroom and individual training and could also be accessed on the project website. The training strategy was to concentrate first on key users, work group leaders, and supervisors. During the first few weeks of the new system, only 60–70 people were allowed to input data transactions. Other users were gradually brought on to the system. This reduced startup problems from poor training (or poor learning) and made it easier to track down and correct process errors. For example, work order operation completions are reported directly into the system by the production workers. This process takes at most a few minutes per day for each individual, but is performed by almost 200 individuals. Until the system was stabilized, the reporting was logged and batch inputted by one work group leader per shift per department. Initial classroom training of the key users (not including the project team) took about 1200 hours. Most training was conducted during the month before the go-live date. Several training rooms were created for this purpose, and concurrent sessions were not unusual.

An unexpected training issue surfaced that affected several different functions. The implementation team focused on training users in areas where the processes had changed. Those users needed specific instruction detailing how to use the new system to perform their daily tasks. However, some business processes were not affected by the new system. When resolving cutover issues, the team found some users who, since they had not been shown a new way to do something, just stopped doing it! This became known as the "hanging your brain on a nail syndrome." To avoid this problem, the implementation team should have compiled and distributed a list of processes that were not changing and needed to be continued as usual.

8.9. Focused performance measures

Huck utilizes a number of highly focused performance and incentive-based measures, including a profit sharing program. The profit share of middle managers is typically based on the achievement of negotiated MBO type goals. When the ERP implementation project began, the involved middle managers' objectives were changed to the single goal of successful system implementation. Additional specific performance measures were developed to measure and motivate the entire work force during the implementation, even as previous

goals and objectives were maintained. The expectation was that the increased efficiency due to the new system would more than offset implementation costs.

8.10. System selection process

The system selection process generally followed the 13 steps described earlier in this article. After analyzing the financial and strategic viability, as well as the geographic support capability of all major software providers, a request for quote was prepared and sent to the 13 qualifying suppliers. Nine responded with formal proposals. The proposals included detailed documentation and manuals describing the products, functionality, and implementation cases. A select team of IS and operations personnel from various Huck sites and a representative from Huck's parent company met for a week to review the proposals. Based on the proposals and some additional solicited information, a short list of suppliers was selected for a complete product demonstration. Two software vendors (SAP and Baan) were selected for the final review.

The demonstration and final selection process was a marathon, six-day event. The selection team was composed of 31 people representing all disciplines and locations that would be implementing the software. Included on the team were internal auditors from the parent company. Each supplier provided a two-and-a-half day demonstration of the software. On the sixth day, the selection team met to compare notes, review strengths and weaknesses, and finally achieve consensus on the best software package. The option to select neither supplier was always kept open. Ultimately, consensus was reached, and Baan software was selected.

The justification criteria demanded by the CEO was that only hard dollars in savings or profit from increased revenue could be used to support the decision. The final justification relied on profit from increased sales through enhanced capabilities, reduced cost of system maintenance, and labor efficiency (reduced head count for a given level of business activity).

There was a major shortcoming in Huck's software selection process. A pre-implementation pilot was not performed. Because of time constraints, it was not even considered. Moreover, the diligent checking of references for first-hand feedback of system performance in real-life situations was not adequately pursued. The resulting lack of information led to a major surprise. Huck fully expected its new ERP system to have a fully integrated, finite production planning and scheduling system. In fact, having a fully integrated system had been a key decision factor in the selection process. But, three months before the targeted "go-live" date, the project team learned that Huck would be a beta test site for the integration interface programming. The integration did not yet exist! Performing a pre-implementation pilot and diligently checking references would have uncovered this fact early on (although it probably would not have changed the software decision). But a major surprise would have been avoided, and the promised and expected benefits would have more easily flowed from the implementation.

8.11. A post-implementation audit

A post-implementation audit was conducted during the spring of 2000, ten months after the "go-live" date. The objective was to determine what areas needed additional assistance in order to more effectively utilize the Baan system. The audit was based on intensive interviews with 51 managers, supervisors, and key employees across 11 different functional areas. A specially designed survey questionnaire was used in all interviews. The interviewees were asked to give both objective and subjective responses to a series of questions covering various aspects of the ERP system and the implementation process. The interviews were conducted by a very capable university intern who had no previous knowledge or biases about the operation of the company.

The analysis of the survey responses revealed a number of interesting results.

- The majority of employees felt that the implementation process was not over. The general belief was that there was still much to learn about how to use the Baan system.
- Effective communications was a major issue throughout the plant. Most employees felt that

the Baan system has great potential, but many found it necessary, or convenient, to go around the system. This caused a "domino effect" of poor information flows throughout the entire company. A number of employees recommended stricter controls and discipline for employees that do not use the system correctly.

- Additional training was commonly identified as a significant need across the organization. While the pre-implementation and cutover training appears to have been adequate, significantly more post-implementation training should have been conducted. A common complaint was that the process of finding needed information was too time consuming. As a result, many users had developed numerous effective, but often inefficient, "workarounds" for problems they encountered. Another common complaint was "the system will not do that" which usually translates to "I do not know how to do that within the system."
- Despite the fact that the majority of the employees stated that they were comfortable with their knowledge of the new system, the most frequent suggestion for improvement within their functional area was additional training.

Spurred by the survey results, tighter system controls have been established. More importantly, widespread additional training was initiated.

8.12. Implementation success?

An ERP implementation is considered to be a success if it achieves a substantial proportion of its potential benefits [7,21]. These benefits might include personnel reductions, a decrease in the cost of information technology, better inventory control, and an improvement in order and cash management. An alternate definition of implementation success is that the system achieves the level of ROI identified in the project approval phase [23]. Thus, an ERP implementation should be evaluated based on cost of ownership versus quantifiable benefits, taking into account the time required to implement the system.

At Huck, to date, ERP implementation costs have exceeded $10 million system-wide. On the benefit side, there is evidence that labor savings and increased profitability have been achieved subsequent to the implementation. For example, the justification process, conducted in early 1998, required a reduction in head count at the primary site of eight to ten people (for the same level of business activity). The reduction was to be achieved six months to a year after implementation. Meanwhile, a labor-intense business unit was consolidated into the facility during the implementation. Consequently, transaction levels in the core business used to justify the implementation increased by 48%. All things remaining equal, with the old MRP II system, approximately 22 new people would have been added in the targeted functions to address the new business volume. With the ERP system, staffing of these functions grew by only 14 individuals. The net difference of negative eight satisfies the justification requirement. One year after implementation, the primary site has seen sales revenue increase by 22%. However, the anticipated increase in revenues that should result from greater compatibility and communication with customers and more open systems has not yet been achieved.

A significant and somewhat unexpected improvement was in the area of inventory control. The finished goods warehouse was converted from zone storage to assigned, random storage using standard features of the new system. By utilizing system rules for lot/location control, the warehouse space requirement was reduced by 40%. Inventory accuracy increased from 94.5% to 98.8%. The improved accuracy would be astonishing even if the error tolerance remained unchanged, but in fact, the current tolerance is much stricter than that used in the past. Previously, a cycle count was considered "bad" if the error was greater than 0.5% of six months usage. The current standard is that the cycle count is "bad" if there is any variance, in any location, or any lot number. The accuracy level is 99.6% in locations that are wholly under control of the warehouse system.

The non-financial improvements are probably the most significant. The company is now positioned to continue to grow and to pursue new partnership opportunities that would not have been possible using the old information system

technology. The company has survived implementation, consolidation, and record growth. Now it can develop new strategies and techniques to manage the business with a powerful and, as yet, relatively underutilized tool.

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